COMMUNICATING EFFECTIVELY ABOUT RISK MAGNITUDES, PHASE TWO

Location on the Page, Units of Exposure Magnitude, Simultaneous Presentation of Two Hazards, and Other Hypotheses

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Rutgers, The State University of New Jersey

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This is a brief summary of key conclusions and recommendations from the research so far. For a longer summary of the Phase Two research, see the Executive Summary or Chapter Four. For a longer summary of the Phase One research, see Chapter One of the Phase Two report or the Executive Summary of the Phase One report.

Probably the most important thing to say about the conclusions and recommendations that will follow is that they are preliminary. The effects we have found are often small, taking a careful study with a big sample to find. They are based on people's reactions to hypothetical exposure data; we do not know if people respond similarly to real exposure data. And they are based on just one or two studies; experienced social scientists know not to rely too heavily on a finding until it has turned up in several different studies using several different methodologies. In addition, participants in this research were much better educated than the general population. Finally, the research design confronted people with personal choices about an individually remediable pollutant in their homes; a public risk controversy might have generated very different responses.

Practitioners cannot usually wait for definitive results, of course. Since you have a job to do, a risk to describe, you are better off following the advice below than ignoring it. But see it as tentative.

It is worth emphasizing that this research effort focuses on ways of explaining risk magnitudes more effectively – that is, ways to help people understand the size of their risk. A more controversial class of risk communication strategies attempt to influence risk responses by manipulating emotions or behavior rather than through improved understanding (examples include dramatic fear appeals, social pressure, rewards for compliance, etc.). These non-cognitive approaches can be very effective – but many scientists object to them.

Five Factors that Affect Risk Response

Data about the Actual Risk. With everything else held constant, subjects responded with higher perceived threat when the data they were given (risk probabilities plus comparisons to smoking) told them the actual risk was higher. In the Phase Two research, a ten-times-higher risk affected risk perceptions but not mitigation intentions; a 24-times-higher risk affected both.

This is an encouraging bottom-line conclusion: Telling people the size of the risk they face does help encourage an appropriate response. But substantial differences in actual risk yield relatively modest differences in perceived risk and action intentions. The Phase One research showed that the effect of data about the risk can easily be swamped by other factors, such as an action standard or a risk ladder.

2. An Action Standard. The Phase One research found that formats that included an action standard were superior to formats without an action standard in helping people respond in proportion to the actual risk. That is, the relationship between actual risk and perceived risk, and between actual risk and mitigation intentions, was stronger with an action standard than without. The effect of

providing an action standard, in fact, was stronger than the effect of providing data about the risk.

The standard was especially powerful in helping people distinguish levels above the standard from those below the standard – so powerful that it sometimes created an artificial discontinuity in risk perceptions at the standard. It also helped people distinguish levels just below the standard from those far below the standard. On the other hand, an action standard did not help people make the distinction between levels just above the standard from those far above the standard.

Practitioners should always provide a standard when one exists, accompanied where appropriate by warnings that risks just below the standard are nearly as risky as those just above, and that risks far above the standard are much more risky than those just above. (An action standard without additional risk information is useful when an apathetic response is anticipated and the goal is to provoke more risk aversion. See Number Four below.)

3. Advice. People said they felt less uncertainty and had a better understanding of their risk when advice was provided. More importantly, people in the Phase One study often said they would mitigate at levels below the standard, but those receiving action advice showed this tendency least. That is, adding advice to the standard made people less likely to "overreact" vis-à-vis the standard, more likely to accept the recommendation not to take action at low levels. Advice was not similarly useful at high levels; it did not increase the probability that those above the recommended action level would plan to act (most already said they planned to act).

Providing explicit advice is thus especially useful for panic prevention, to deter overreaction at low risk levels. Its value for increasing remedial action at high levels (beyond what would be expected with a standard alone) has not been demonstrated.

4. A risk ladder. People felt more at risk when presented simply with a suggested "action level" at which mitigation is recommended than when presented with such a standard located midway up a risk ladder. In the Phase One research, the ladder included mortality data and risk comparisons; in Phase Two it did not. In both studies, the context that the ladder provided – the information that levels higher than one's own are not rare – appeared to reassure subjects and reduce their perception of risk. In Phase Two, the presence or absence of a risk ladder, even without any additional information, had an effect on perceived risk equal to a several-fold difference in actual risk.

If the communicator's goal is maximum risk aversion – that is, if the hazard is serious and the audience is inclined toward apathy – a standard without additional information is ideal; its very ambiguity generates the desired risk-averse response. If panic is a problem and the goal is to provide reassuring context, on the other hand, a risk ladder is worth adding.

5. Location on the Risk Ladder. By displacing the risk ladder, the Phase Two research located the same hypothetical reading with the same risk information either one-quarter of the way up the ladder or three-quarters of the way up the ladder. The resulting locational effect significantly affected perceived risk in two experiments, and mitigation intentions in one. This locational effect was roughly equivalent in size to the effect of an order of magnitude of actual risk. Risk information developed to guide laypeople is often arrayed on a risk ladder, and the structure of the ladder may be determined more or less arbitrarily. How low should the ladder begin? How high should it rise? Should the scale be linear or logarithmic? The answers to these questions are not obvious. What is clear from the data is that people's risk perceptions can be substantially altered – whether intentionally or arbitrarily – by constructing the ladder so that their risk appears low or high on the page.

It may be impossible to construct a risk ladder that makes optimal use of the locational effect for all risk levels included on the ladder. For helping people distinguish between high and low levels of a particular risk, X, the most effective ladder would be truncated at both ends, so that high levels of X appeared at the top of the ladder and low levels of X at the bottom. For helping people see that X is actually less serious than Y, on the other hand, the ideal ladder would be extended upward, so that all levels of X clustered near the bottom of the ladder. The best ladder to help people see that X is actually more serious than Z would be extended downward, clustering all the levels of X near the top. A "universal ladder" incorporating all three risks would extend both upward and downward, and would cluster all the levels of X near the middle. These three extended ladders would all be improvements on the original truncated ladder in encouraging an appropriate response to between-hazard risk differences – but they would all be worse than the original in encouraging people to discriminate within-hazard risk differences.

Six Factors that May Not Significantly Affect Risk Response

1. Risk Comparisons. In the Phase One research, the use of risk comparisons to cigarette smoking had two effects: it made people feel the brochure was more helpful and they understood their risk better, and on some measures it made them less risk-averse (for example, the comparisons raised the highest level people would find acceptable). However, the comparisons had no effect on people's ability to distinguish high risks from low risks: no effect on the accuracy of illness probability estimates or on the relationship between actual risk and perceived risk or mitigation intentions. In other words, the impact of risk probability data was not improved by the inclusion of comparisons to smoking risks.

Risk comparisons may of course prove more helpful in ways not examined in this research – different comparisons, different situations – but the research so far provides little guidance on how to deploy risk comparisons usefully.

2. Graphical Presentation. A bar graph showing risk probabilities at different exposure levels functioned in the Phase One research exactly like risk comparisons. It improved people's ratings of the helpfulness of the brochure and their certainty about their risk, and made them somewhat less risk-averse. However, there were no significant differences between graphical and strictly quantitative presentations of risk data in the extent to which people distinguished high levels from low levels or radon from asbestos. Graphical display, in other words, did not strengthen the relationship between the actual risk and people's responses to that risk.

It is of course possible that different graphical devices would show a greater impact on risk response.

3. Test Magnitude. The Phase Two research tested the hypothesis that people respond to risk data in terms of the magnitude of the test numbers themselves, quite apart from the risk represented by those numbers. By expressing asbestos risk alternatively in fibers per liter and in fibers per cubic foot, a 30-fold difference in test magnitude was achieved without any difference in risk (as presented in terms of probabilities plus smoking comparisons). No significant effects of the test magnitude manipulation were found.

This somewhat surprising finding is reassuring. Concentration levels for radon in water, for example, are typically much greater than for radon in air, although the waterborne risk is usually lower. It is encouraging that homeowners are apparently able to disregard the misleading test magnitude cue, at least when mortality information and smoking comparisons are also provided.

4. Hazard Differences. The Phase Two research found no differences between radon and asbestos in the composite threat perception index or in mitigation intentions, when risk level and location on the page were held constant. The three hazard attributes on which radon and asbestos were perceived differently – difficulty of reducing the risk, unfamiliarity, and natural/man-made – were not

significantly correlated with risk response. By contrast, the two attributes on which radon and asbestos were _not_ perceived differently – dread and lethality – _were_ significantly correlated with perceived risk. Thus, although radon and asbestos are perceived differently with respect to some hazard characteristics, these are not the characteristics that are tied to perceived riskiness.

A different pair of hazards – radon and nuclear waste, perhaps – that differed in dread or perceived lethality would be expected to differ in perceived risk as well.

5. _Simultaneous Presentation_. The final factor tested in the Phase Two research was the possibility that the simultaneous presentation of asbestos and radon risks on the same ladder might help subjects understand that the asbestos risk was less serious than the radon risk. This hypothesis was rejected. There were no significant differences between the joint and separate presentations for either radon or asbestos.

Of course it is possible that a different use of simultaneous presentations might help owners take note of risk differences – for example, presentations that included the different action levels for the two hazards, or presentations that directed readers' attention to the differences more forcefully or interactively.

6. _Information Overload_. One of the formats tested in Phase One presented more information than any other (risk probability data, risk comparisons, an action standard, advice, verbal labels, a risk ladder). Yet it scored as well as or better than the other formats on almost all measures of communication success, including people's certainty about the risk and their evaluations of the amount of information provided and the helpfulness of the brochure.

"Information overload" may be an issue for still more complex presentations of risk information, or for audiences that are less interested or less educated. But no evidence of overload has been found for the formats tested so far. For most uses, in fact, this "maximum information" condition is probably optimal. The likely exceptions would be cases where no action standard exists or where apathy is a major problem and the communicator wishes to encourage maximum risk aversion.

The Bottom Line

In general: Don't worry about information overload. Always include an action standard if one exists. Except where maximum risk aversion is your goal, always include risk probability data (if they are available), an appropriately constructed risk ladder, and advice for different levels.

If you are worried about apathy and want to encourage maximum risk aversion: Give people a standard and no other risk information.

If you are worried about panic and want to encourage minimum risk aversion: Give people advice for different levels, specifying at what levels you recommend action and at what levels you recommend doing nothing. Include a risk ladder that extends to levels higher than those your audience will experience.

If you are trying to help people distinguish high from low levels of a single hazard: Construct a risk ladder with the high levels at the top and the low levels at the bottom.

If you are trying to help people distinguish between hazards or understand that all levels of a particular hazard are relatively high or low in risk: Construct a ladder that is extended upward or downward, so that the hazard you want to depict as low has all its levels near the bottom of the ladder, and the hazard you want to depict as high has all its levels near the top.

EXECUTIVE SUMMARY

It is difficult to convey information to citizens about the magnitudes of risks to which they are exposed. As many discouraged policy-makers have discovered, citizens often ignore information designed to alert them to significant and remediable risks, and thus fail to take appropriate action. Yet these same citizens may insist on remedial action with respect to other risks that are too improbable or too irremediable to merit the attention they receive.

Studies have identified many factors other than risk magnitudes that influence how the public responds to particular risks. Much less research has attempted to determine how to explain the magnitudes of risks, and thus to improve the correlation between risk and response.

To fill this important gap in our knowledge, the Environmental Communication Research Program at Cook College, Rutgers University and the U.S. Environmental Protection Agency undertook the research reported here. This is the second phase of an on-going research effort. The report of the Phase One research was published in September 1989 (Communicating Effectively about Risk Magnitudes, by Neil D. Weinstein, Peter M. Sandman, and Nancy E. Roberts), and is available from either the Environmental Communication Research Program or the U.S. Environmental Protection Agency.[1]

The overarching question examined by the present research is the extent to which different ways of presenting risk data can help individuals perceive their risk accurately and respond appropriately. Each subject received one hypothetical home test result for either asbestos or radon contamination (in one condition subjects received both an asbestos and a radon reading). The experimental manipulation was a one-page explanation of the dose-

[1]For copies, write or call either: Environmental Communication Research Program, P.O. Box 231, Cook College, Rutgers University, New Brunswick, NJ 08903, (908) 932-8795; or Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, PM-220, Washington, DC 20460, (202) 382-6995.

risk relationship included as part of a four-page information brochure provided by the researchers. Subjects used this information to assess the risk associated with their assigned test result; their answers to questions about the risk constituted the measure of the impact of the experimental treatment.

Three experiments were conducted, all using randomly selected central New Jersey homeowners who had not in fact tested their homes for the hazards in question. The three studies are referred to throughout this report as Experiments I, II, and III respectively. A total of 1,418 subjects provided usable data, each for one experiment only.

Five measures of risk perception were used. The most sensitive of these was the composite index of threat perception, comprising four items that were strongly intercorrelated: perceived likelihood of harmful effects, perceived seriousness, concern, and fear. A single question about mitigation intentions was treated as a second dependent variable, in order to have a behavioral measure. The third dependent variable was subjects' estimates of illness probability. Except in the first experiment, the experimental manipulations provided explicit data on illness probability; this item was therefore conceptualized more as a comprehension item than as a risk perception item. The last two dependent variables were judgments of mitigation difficulty and choices of the highest asbestos or radon level subjects would find acceptable (that is, would choose not to mitigate). None of the experimental manipulations addressed these two issues directly; accordingly, no impact was predicted.

The findings are discussed below in terms of the first two dependent variables, the composite index of threat perception and mitigation intentions. In general, effects on the composite index were stronger than effects on the single-item measure of mitigation intentions, though both were usually in the same direction. This is probably attributable to the greater sensitivity of the composite index, rather than to any difference in how perceptions and intentions are affected by the experimental variables.

Six different factors were examined (in one or more of the three experiments) to determine their impact on subjects' risk perception: actual risk probability, the presence of a risk ladder, location on the risk ladder, units of exposure magnitude, differences between two hazards, and simultaneous presentation of two hazards. Care was taken to make sure each factor was varied separately, with the others tightly controlled. Effects were found for the first three factors, but not for the second three. The results will be discussed in the order in which the factors are listed. Three additional findings are mentioned briefly at the end.

1. <u>The risk magnitude effect</u>. Both Experiment II and Experiment III included a test of the impact of actual risk on subjects' risk perceptions (risk was explained in terms of expected mortality and comparisons to smoking). In Experiment II, a 10-fold increase in risk significantly increased the composite index of perceived threat, but had no significant

effect on mitigation intentions. In Experiment III, a 24-fold increase in risk significantly increased both the composite index and mitigation intentions.

The finding that risk affects risk perception is not surprising. On the contrary, it would be shocking if risk variations of an order of magnitude or more were invisible to subjects instructed to make judgments about the extent of their risk. This is especially the case in the relatively serious range of hypothetical risks to which subjects were assigned (3 and 30 deaths per thousand in Experiment II, 5 and 120 deaths per thousand in Experiment III). Comparable differences in deaths per billion might well have had negligible effects.

The finding of a significant risk effect should not be interpreted as meaning that subjects had a thorough understanding of the risk data presented to them -- much less that they were prepared to act on that understanding. The only dependent variable with a "right answer" was illness probability estimates. Subjects in all conditions tended to underestimate their risk, and those in the high risk conditions underestimated it the most. That is, illness probability estimates did increase as actual risk (that is, actual illness probability) increased, but the gap of unrealistic optimism also increased with increasing risk.

2. The effect of a risk ladder. Experiment I tested the hypothesis that subjects would perceive their risk to be greater when presented simply with a suggested "action level" at which mitigation is recommended than when presented with such a standard located midway up a risk ladder. Even though the ladder did not include risk data, the context it provided -- the information that levels higher than one's own are not rare -- was expected to reassure subjects and thus reduce their perception of risk.

The hypothesis was confirmed, albeit weakly, for the composite index of perceived threat, but not for mitigation intentions.

The finding that a risk ladder reduces perceptions of threat helps explain the Phase One finding that subjects were most risk-averse when presented simply with a standard (as opposed to other treatments that provided risk data, risk comparisons, advice, etc.). Apparently, people presented simply with two pieces of information, the recommended action standard and their own reading, are likely to interpret this information in alarming ways. The mere addition of a risk ladder tells them nothing about death rates at the different levels, or even about the frequency with which these levels are encountered. But the range of levels included on the ladder at least suggests the range of levels that experts must expect people to encounter. This contextual information appears to reassure subjects somewhat, especially when their readings are above the action standard.

The size of the risk ladder effect cannot be compared directly with the size of the risk effect, since they were studied in different experiments. But indirect comparison is possible. Averaged across all hypothetical test results, the addition of a risk ladder decreased the composite threat perception index by 0.86 units on a 19-unit scale (4.5% of the total scale range); above the standard, where the reassuring effect was stronger, the decrease averaged 1.23 units (6.5%). In Experiment II, the effect of a 10-fold increase in risk was 1.78 units (9.4%); in Experiment III, a 24-fold increase in risk yielded an average increase in perceived threat of 3.69 units (19.4%). The presence or absence of a risk ladder thus has an effect on perceived risk equal to a several-fold difference in actual risk.

The effect is large enough to be of practical value. If the communicator's goal is maximum risk aversion – that is, if the hazard is serious and the audience is inclined toward apathy – a standard without additional information is ideal; its very ambiguity generates the desired risk-averse response. If panic is a problem and the goal is to provide reassuring context, on the other hand, a risk ladder is worth adding.

3. The effect of location on the risk ladder. The locational hypothesis was introduced at the end of the Phase One research to account for that study's finding that many formats were able to help subjects distinguish the risk of high versus low levels of asbestos or radon, but no format successfully helped subjects distinguish the risk of asbestos from the risk of radon. The risk associated with a particular level of asbestos or radon, it was noted, was proportional to that level's location on the risk ladder (higher risks were higher on the ladder), while the difference in risk between asbestos and radon was not reflected in their respective ladders. If subjects were responding to location on the ladder rather than to risk information, therefore, their risk perceptions would be sensitive to within-hazard differences but not to between-hazard differences – exactly what the Phase One data had shown.

The locational hypothesis was tested in Experiments II and III. By displacing the risk ladder, the same hypothetical reading with the same risk information was located either one-quarter of the way up the ladder or three-quarters of the way up the ladder. Both experiments found a significant locational effect on the composite index of perceived threat. In Experiment II, a displacement of half a page led to a 1.49-unit effect on the 19-unit threat perception index (7.8% of the total scale range), while a 10-fold difference in actual risk produced an effect of 1.78 units (9.4%). In Experiment III, a displacement of half a page yielded a difference of 2.70 units (14.2%) in the composite index of perceived risk, while a 24-fold risk difference added another 3.69 units (19.4%). The findings with respect to mitigation intentions were less compelling. In Experiment III, the effect on mitigation intentions was statistically significant, but in Experiment II it was too small to achieve statistical significance. This is probably a result of the insensitivity of the single-item measure of mitigation intentions, not an indication that location on the risk ladder affects perceptions more than intended behavior.

The effect of location on risk perception is a sizable effect and an important finding. Risk information developed to guide laypeople is often arrayed on a risk ladder, and the structure of the ladder may be determined more or less arbitrarily. How low should the ladder begin? How high should it rise? Should the scale be linear or logarithmic? The answers to these questions are not obvious. They depend not just on the seriousness of the risk and the anticipated apathy or panic of the audience, but also on the actual range of levels that are typically encountered and on the ethical values of those constructing the ladder. What is clear from the data is that people's risk perceptions can be meaningfully altered – whether intentionally or arbitrarily – by constructing the ladder so that their risk appears low or high on the page.

4. The effect of test magnitude. In the Phase One research, radon exposures were expressed in picoCuries per liter, while asbestos exposures were in fibers per liter. The risk associated with a level of radon with the same numerical test magnitude was substantially higher than the risk associated with that level of asbestos; that is, X pCi/l of radon constitutes a greater risk than X f/l of asbestos. This suggested another possible explanation for the difference between within-hazard effects and between-hazard effects found in Phase One. Perhaps subjects responded appropriately to differences in level within a hazard because the test numbers themselves varied with the risk, while failing to respond to between-hazard risk differences because the numbers were not substantially different.

This hypothesis was tested in Experiment II. By expressing asbestos risk alternatively in fibers per liter and in fibers per cubic foot, a 30-fold difference in test magnitude was achieved without any difference in risk.

No significant effects were found. In fact, the composite index of perceived threat and the measure of mitigation intentions were actually somewhat lower – though not significantly so – in the High Test Magnitude condition than in the Base condition. This somewhat surprising finding is reassuring. Concentration levels for radon in water, for example, are typically higher than for radon in air, although the waterborne risk is usually lower. It is encouraging that homeowners are apparently able to disregard the misleading test magnitude cue, at least when mortality information and smoking comparisons are also provided.

5. The effect of hazard differences. A third possible explanation was also considered for the Phase One finding that subjects were more sensitive to within-hazard risk differences than to between-hazard risk differences. Perhaps there were particular characteristics of the two hazards, asbestos and radon, that made the former more alarming to subjects than the latter, thus tending to cancel out the effects of the fact that the latter was the greater risk (at the levels specified).

Experiment III tested for risk perception differences between radon and asbestos. To help account for any differences that might emerge, Experiment III also added measures of five hazard characteristics: difficulty of reducing the risk, dread, lethality, unfamiliarity, and the natural/man-made distinction.

Surprisingly, no differences were found between radon and asbestos in the composite threat perception index or in mitigation intentions, when risk level and location on the page were held constant. Of the five hazard characteristics measured, three – difficulty of reducing the risk, unfamiliarity, and natural/man-made – showed significant differences between radon and asbestos; radon was seen as easier to mitigate, less familiar, and less man-made than asbestos. None of these three hazard characteristics showed significant correlations with the dependent variables. By contrast, the other two characteristics – dread and lethality – were significantly correlated with perceived risk, but did not significantly distinguish radon from asbestos. Thus, although radon and asbestos are perceived differently with respect to some hazard characteristics, these are not the characteristics that are tied to perceived riskiness. Two different hazards – radon and nuclear waste, perhaps – that differed in dread or perceived lethality would be expected to differ in perceived risk as well.

6. The effect of simultaneous presentation. The final factor tested in the Phase Two research was the possibility that the simultaneous presentation of asbestos and radon risks on two parallel ladders – in effect, on the same ladder – might help subjects understand that the asbestos risk was less serious than the radon risk. This was tested in Experiment III, and the hypothesis was rejected. There were no significant differences between the joint and separate presentations for either radon or asbestos. Of course it is possible that a different use of simultaneous presentations might help owners take note of risk differences – for example, presentations that included the different action levels for the two hazards, or presentations that directed readers' attention to the differences more forcefully or interactively.

It should be noted that the simultaneous presentation hypothesis was very narrowly framed in the present study. That is, location on the risk ladder was held constant. Whether the two hazards were presented simultaneously or separately, the asbestos risk was always one-quarter of the way up the ladder, and the radon risk was always three-quarters of the way up the ladder. In many practical applications, by contrast, presenting two hazards simultaneously would mean extending the risk ladder upwards and downwards to encompass the range of risks entailed by the two different hazards. Since the normal range of asbestos hazards is lower in risk than the normal range of radon hazards, a joint presentation as opposed to separate presentations would tend to move asbestos readings farther down on the page and radon readings farther up. The locational effect would thus decrease asbestos risk perceptions and increase radon risk perceptions – even if there were no added effect of simultaneity.

To put this point another way, the findings that have been discussed so far strongly support the locational explanation for the Phase One result that subjects are much better able to distinguish within-hazard risk differences than between-hazard risk differences, at least insofar as asbestos and radon are concerned. Phase One subjects had trouble recognizing that radon was a more serious risk than asbestos, the Phase Two results strongly suggest, not because they were misled by differences between the two hazards or by similarities in the numerical size of the test numbers, but because radon and asbestos were each presented on a separate risk ladder that encompassed a limited range of risks. On a "composite" risk ladder that ran from the lowest level of the asbestos ladder to the highest level of the radon ladder, the findings suggest, asbestos risk perceptions would be diminished and radon risk perceptions would be augmented.

It may be productive to envision a "composite" risk ladder embracing a still wider range of hazards – one that can cover highly unlikely risks (pedestrian is struck by lightning) at the bottom of the ladder and highly likely ones (smoker gets lung cancer) at the top. If such a ladder can be devised in a way that is comprehensible to laypeople (it would have to be logarithmic, certainly), it should excel at helping people perceive between-hazard differences. But within-hazard differences would be compressed into a small portion of this expanded ladder. Inevitably, therefore, the composite ladder would be much less successful than narrower single-hazard ladders at pointing to within-hazard differences.

7. Three other findings. Three other findings of interest concern demographics, estimates of illness probability, and maximum acceptable levels.

- Older subjects tended to be less risk-averse than younger subjects; less educated subjects tended to be less risk-averse than more educated subjects; men tended to be less risk-averse than women. However, none of the associations between a demographic variable and a risk perception variable was significant for all three experiments.

- As mentioned earlier, subjects were consistently low in their estimates of illness probability, even though the information called for in the questionnaires was provided in the brochures. Although risk probability estimates increased as the actual risk increased, so did the extent of the underestimation.

- Subjects' judgments of the highest exposure level they would consider acceptable varied depending on the options provided; when responses were converted into a simple 1-12 scale independent of the options provided, no significant differences were found. This suggests that subjects did not choose a particular level of risk in response to the question, but rather selected a choice that was a few responses away from the first option, zero. In essence, they chose a location, not a risk. Subjects' highest acceptable levels were usually significantly lower than the EPA action guidelines provided.

CHAPTER ONE

INTRODUCTION

The Research Problem

There is considerable agreement about the difficulty of conveying information to the public about the magnitudes of risks. As many policy-makers have noted in discouragement, citizens often ignore information designed to alert them to significant risks, and thus fail to take appropriate individual action; yet these same citizens may insist that government or industry take inappropriate remedial action for other risks that are too small to merit the attention they receive. Even within the realm of individually mitigable risks, studies of the public response to radon, for example, have shown a less-than-ideal relationship between the individual's test result and his or her response. Furthermore, the response to risk data about one hazard is often very different from the response to data about a different hazard. Some hazards seem to provoke great anxiety in the public, while others – even given test results that indicate a comparable risk – elicit much less concern.

A substantial research literature has identified many of the factors other than risk magnitudes that seem to determine how the public responds to particular risks. But much less research has sought the best ways of explaining risk magnitudes, with the goal of improving the correlation between risk and response.[2] Until the research whose second

[2]For an excellent introduction to the relevant issues, see National Research Council, Improving risk communication. Washington, DC: National Academy Press, 1989 (see especially Appendix C, by B. Fischhoff). A brief review of empirical risk communication

stage is reported here, there has been relatively little empirical data to support claims that one approach works better than another.[3]

It is worth emphasizing that this research effort focuses on ways of explaining risk magnitudes more effectively – that is, ways to help people understand the size of their risk. A more controversial class of risk communication strategies attempt to influence risk responses by manipulating emotions or behavior rather than through improved understanding; examples include dramatic fear appeals, social pressure, rewards for compliance, etc. These non-cognitive approaches can be very effective – but many scientists object to them, believing that risk is a technical problem that should be explained in technical (though in understandable and perhaps simplified) terms. The research whose second phase is reported here represents one of the most sustained efforts to date to find out how far cognitive approaches can bring us: how much risk responses can be shaped by effectively presented data alone.

Summary of Phase One[4]

The research conducted in the first funding period raised issues explained further in the Phase Two research. Before detailing the Phase Two hypotheses, methods, and

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studies can be found in Rohrmann, 1990.

[3]Although the research literature on this issue is limited, research by Smith, Desvousges, and colleagues deals usefully with the relatively effectiveness of different formats for explaining radon risks. See for example: Smith, V.K., Desvousges, W.H., Fisher, A., and Johnson, F.R. (1987). Communicating radon risk effectively: A mid-course evaluation. Washington, DC: Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency (EPA-230-07-87-029).

[4]A complete report on the Phase One findings was published in September 1989. For copies, write or call either: Environmental Communication Research Program, P.O. Box 231, Cook College, Rutgers University, New Brunswick, NJ 08903, (908) 932-8795; or Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, PM-220, Washington, DC 20460, (202) 382-6995. Weinstein, N., Sandman, P., and Roberts, N., Communicating Effectively about Risk Magnitudes.

findings, a brief summary of Phase One findings and conclusions is appropriate.

The Phase One research examined a variety of promising risk presentation formats and tested their success in communicating about two different hazards, geological radon and asbestos. These two hazards have several common properties: They confront individual homeowners rather than being community-wide problems; tests can be carried out (and must then be communicated) to indicate the seriousness of the risk; and individual-level mitigation is possible. Among the other hazards that fall into this important category are lead contamination from water pipes within the home, contamination of home wells by toxic chemicals in groundwater, and emissions from urea-formaldehyde foam used as insulation.

Successful communication about this class of hazards is particularly important because it can increase the likelihood that people take actions to reduce health risks when such actions are appropriate, and can decrease the likelihood of excessive worry and unneeded action when risk levels are low. Different communication strategies may be appropriate for hazards that do not permit individuals to assess their own risk and make their own decisions about mitigation.

Seven formats were evaluated, as follows:

F1. <u>Risk Probabilities</u>. Information about expected lifetime mortality (deaths per thousand people) at various levels of exposure.

F2. <u>Risk Probabilities and Comparisons</u>. F1 with comparisons to smoking risks added.

F3. <u>Graphic Probabilities</u>. F1 displayed in histogram form.

F4. <u>Standard</u>. Information about the recommended action level only.

F5. <u>Standard + Risk Probabilities and Comparisons</u>. F4 + F2.

F6. <u>Standard + Advice</u>. F4 with detailed action advice and verbal labels for four ranges of exposure levels.

F7. <u>Standard + Advice + Risk Probabilities and Comparisons</u>. F6 + F2.

For reasons that will become clear later in this summary, it is important to note that five of the seven formats visually displayed exposure levels in the form of a vertical ladder (F1, F2, and F5 through F7); in F3 the horizontal axis represented radon exposure and histogram bars indicating risk rose from this axis. Only F4 had no visual representation of exposure levels.

Also important to understanding these results is the fact that the recommended action level for radon represents approximately a 25-fold greater risk than the action level used for asbestos.

Subjects were New Jersey homeowners who had in fact <u>not</u> tested their homes for the hazard in question (either radon or asbestos). Each subject was asked to assume that he or she had tested and obtained a specified reading (in picoCuries per liter for radon and in fibers per liter for asbestos). Four readings were used for each hazard, one well below the recommended action level, one slightly below the level, one slightly above the level, and one well above the level. (The risk associated with each specified radon reading was roughly 25 times the risk associated with the comparable asbestos reading.) Each subject also received a four-page brochure discussing the hazard in question. The first three pages were constant across conditions; the fourth page consisted of the experimental manipulation. Each subject received one hypothetical reading for either radon or asbestos and one brochure explaining the hazard and its risk.

Subjects then responded to an evaluation questionnaire. Dimensions covered included: audience evaluation of the brochures, perceived risk seriousness, likelihood of illness, concern, fear, mitigation difficulty, intentions to take action, maximum acceptable exposure levels, and numerical estimates of illness probability. Responses to the risk seriousness, illness likelihood, concern, and fear questions were highly correlated with one another and were therefore combined to form a single measure of "perceived threat."

The experimental design thus comprised seven presentation formats, four exposure levels, and two hazards -- a total of 56 cells. The final sample consisted of 1,948 subjects, an average of 35 subjects per cell.

The discussion that follows summarizes the major findings from Phase One and their implications.

1. The value of the research design. The experimental design using hypothetical exposures proved to be a very efficient, cost-effective, and flexible way to investigate format effects on risk perception and behavioral intentions. It would have been extremely difficult and costly to find subjects who had actually tested for the hazards in question, yet had not had access to extensive information from other sources (confounding any possible study results). Moreover, supplying such subjects with suboptimal information would have posed substantial ethical problems. Subjects found the experimental task interesting and comprehensible. Their responses suggest that they took the task seriously, and meaningful differences were found in their responses to the seven formats. Ultimately, it will be important to field test key findings obtained by this methodology, to identify any differences that may exist between responses in the hypothetical testing situation and responses in a real testing situation. But we now have in hand a methodology and a frame suitable for testing increasingly sophisticated hypotheses about the effects of risk presentation formats.

2. The effect of an action standard. Formats F4 through F7 included an action standard – a level (midway between the second and the third exposure levels) below which mitigation was not recommended, and above which it was. Formats F1 through F3 did not. One important goal for communicating risk magnitudes is to have people with low readings see their threat as smaller and less often undertake remedial action than people with high readings. The formats with an action standard were superior to the formats without an action standard according to this goal.

The presence of a standard not surprisingly increased the likelihood that subjects' action intentions matched the action recommendations; in other words, subjects were more likely to plan to mitigate at levels above the action standard and to plan not to mitigate at levels below the standard if they were told what the standard was. Though obvious, this is not a trivial finding; it shows that explicit action standards significantly affect individual action plans, and thus can contribute meaningfully to public health.

However, the presence of a standard also created an artificial discontinuity in hazard responses as one goes from just below the standard to just above the standard. This discontinuity or "step" exaggerated the minimal increase in actual risk between the second specified exposure level and the third. This effect, too, is not surprising; many commentators have complained about the public's tendency to dichotomize around a standard, perceiving levels just below the standard as safe and those just above as risky. The discontinuity found was, if anything, smaller than might have been expected.[5]

(Responses to an action standard are presumably influenced by people's beliefs about government regulation and regulatory standards, especially whether they are likely to be too lax or too tight. Among those who take a standard literally, the greater the trust in the standard, the greater the expected discontinuity in risk response above versus below the standard.)

More surprisingly, F4 through F7 did a better job than F1 through F3 of helping subjects distinguish between very low and moderately low readings. That is, the presence of a standard helped subjects understand that levels just below the standard were appreciably more risky than levels far below the standard. A similarly improved differentiation between high and very high levels was not found; the action standard did not affect the difference between reactions to high and reactions to very high test results.

3. The effect of the standard-only condition. Although four formats (F4 through F7) included an action standard, only F4 provided the standard without any additional information – that is, without a risk ladder, without risk probabilities or risk comparisons, and without advice and verbal labels keyed to various levels.

This condition stood out from the others in many ways. Most importantly, it led to the highest perceptions of threat and the greatest intentions to mitigate (especially at levels below the standard). It also produced the most risk-averse responses on several other

[5]Studies of actual radon mitigation suggest that an action guideline or standard may lead to an artificial step in risk perceptions but not in behavior. See Doyle et al., 1991, and Weinstein and Sandman, 1991.

outcome measures. These findings strongly suggest that an action standard without additional risk information is useful when an apathetic response is anticipated and the goal is to provoke more risk aversion (so long as the overresponse is not excessive). Where panic and overreaction are likely responses, on the other hand, a standard-only communication should be avoided.

The differences obtained between format F4 and formats F5 through F7 were greater than can be explained by the risk probability information (F5 and F7), risk comparisons (F5 and F7), or advice (F6 and F7) that these other formats contained. The authors speculated that the uniquely risk-averse responses to F4 might have resulted from the fact that F4 lacked the risk ladder present in F5 through F7. In the absence of a ladder, subjects had no way of telling what range of test results is "typical"; they might therefore have reacted as though the finding of any amount of radon or asbestos were a serious problem. In contrast, subjects who had a ladder and a low test result could see that their exposure level was low on the page, a reassuring observation. Even if their level was above the standard, the presence of still higher rungs on the ladder may have been reassuring. Individuals with results on the very top rung of the ladder might have become more frightened than subjects with no ladder at all. (This was not tested; the highest hypothetical level used was still well below the top of the ladder.) For everyone else, however, an exposure ladder appeared to be reassuring, and the absence of a ladder in format F4 appeared to lead to increased risk aversion.

4. The effect of advice. Two formats (F6 and F7) went beyond the dichotomy created by the standard to provide verbal labels and action advice at different levels. Although people in this study tended to be more risk-averse than the action recommendations (they often said they would mitigate at levels below the standard), those receiving action advice showed this tendency least. That is, they were the most likely to accept the recommendation not to take action at low levels, the least likely to "overreact" vis-à-vis the standard. Subjects also reported less uncertainty and better understanding of their risk when advice was provided.

It is not surprising that the presence of more graduated and detailed advice than a simple standard increased the likelihood that subjects would act in ways consistent with what was advised. However, the effect was not true for all risk levels. Subjects receiving formats F6 and F7 were less risk-averse at low levels than subjects receiving format F4 (standard-only), but they were not more risk-averse at high levels. Providing explicit advice is thus especially useful for panic prevention, to deter overreaction at low risk levels. Its value for increasing remedial action at high levels (beyond what would be expected with a standard alone) has not been demonstrated.

5. The effect of risk probability data or probability data plus comparisons to smoking. Risk probability information was provided in formats F1, F2, F3, F5, and F7; it was accompanied by comparisons to smoking in F2, F5, and F7. Subjects receiving these formats did a better job of estimating illness probabilities at their levels than subjects receiving no risk probability information. This shows that the risk probability information was not totally ignored or totally incomprehensible. But the improvement in illness probability estimates was not matched by any change in perceived threat or mitigation plans. Analysis of F4 versus F5 and F6 versus F7, for example, shows that the addition of risk probability data (plus comparisons) did not lead to a further differentiation between high and low risks beyond that produced by the standard alone (F4) or the standard plus advice (F6).

In short, people seemed somewhat able to understand risk probability information – that is, to respond to risk probability questions in a way that was systematically related to the information provided – but no format was found that helped them integrate this information into their views of the seriousness of the threat or the need for action. When a standard was provided, furthermore, the effect of the standard seemed to vitiate the much weaker effect of the risk probability information.

6. The effect of risk comparisons and a graphical presentation. Format F2 added comparisons to smoking to the risk probability information in format F1; format F3 displayed the information from F1 in the form of a histogram. Both comparisons to

smoking and graphical display improved subjects' ratings of the helpfulness of the brochure and their certainty about their risk. On two of the four measures of risk aversion, risk comparisons and graphical display also had the effect of making subjects less risk-averse; for example, when they were asked what levels they would find personally acceptable, higher responses were given by subjects receiving formats F2 and F3 than by subjects receiving format F1.

However, there were no significant differences between F2 and F1 or between F3 and F1 in the extent to which subjects distinguished high levels from low levels or radon from asbestos. That is, comparisons and graphical display had no effect on the accuracy of illness probability estimates, or on the variation in threat perceptions or action plans with level or with hazard. Comparisons and graphical display, in short, helped subjects feel that they understood their risk better, and made them less risk-averse, but did not in fact strengthen the relationship between the actual risk and subjects' responses to that risk. It is of course possible that different comparisons or different graphical devices would show a greater impact on risk response.

7. The effect of providing maximum information. Format F7 presented more information than any other (i.e., risk probability data, risk comparisons, an action standard, advice, and verbal labels). Except for the histogram in format F3, F7 had everything that any other format had. Yet it scored as well as or better than the other formats on almost all measures of communication success, including subjects' evaluations of the helpfulness of the brochure and their certainty about the risk. We found no evidence that subjects were confused by "information overload" in format F7.

Of course, format F7 is not an option if the communicator is not prepared to provide an explicit standard and action advice. And it is probably not advisable in cases where apathy is a major problem and the communicator wishes to encourage maximum risk aversion in the audience. (The decision to "encourage" this or any particular response in an audience raises values issues as well as empirical ones, of course.) For most other purposes, however, F7 was the format of choice among the seven tested.

8. Responsiveness to risk magnitude information. None of the formats tested succeeded in giving subjects an accurate sense of the magnitude of their risk. All seven formats did a fair job of producing threat perceptions and action plans that varied with the level of radon or asbestos (F4 through F7 did best), but none of them was really able to produce threat perceptions and action plans that were appropriately different for radon than for asbestos. Yet the level of risk for each radon reading was roughly 25 times the risk for the comparable asbestos reading. That is, the lowest radon reading was 25 times as risky as the lowest asbestos reading, and the highest radon reading was also 25 times as risky as the highest asbestos reading. None of the formats tested did an adequate job (and none did appreciably better than the others) in helping subjects recognize this major between-hazard difference.

It is not surprising that formats F4 and F6 failed in this regard. They provided an action standard that ignored the difference between radon and asbestos and no risk probability information to point out that difference. Thus, F4 and F6 suggested implicitly that radon and asbestos risks are about equal. It is somewhat more surprising that the risk probability information in F5 and F7 did little to overcome the misleading impression created by the standard. But it is believable that an action standard is a stronger cue than risk data.

What is most surprising is the fact that, for most outcome variables, even formats F1 through F3 -- formats with risk probability information and no action standard -- produced no greater differences between the two hazards than the other formats. Of the seven formats tested, formats F1 through F3 would be expected to yield the greatest realization that radon is more hazardous than asbestos at the same exposure level. (Formats explicitly pointing out the difference between radon and asbestos or offering a different action guideline for the two hazards were not tested.) In fact F1 through F3 did produce slightly more awareness of the radon-asbestos distinction in estimates of illness probability, but not in threat perceptions or action plans.

Hypotheses for Phase Two

Phase Two was designed to resolve some of the issues raised by the Phase One results.

Experiment I. The first new experiment was suggested by an unexpected Phase One observation. As noted earlier, reactions to the standard-only format stood out in the Phase One findings. On a variety of measures (perceptions of threat, intentions to mitigate, levels judged personally acceptable, etc.) the standard-only condition produced the most risk-averse response. The authors hypothesized that the strongly risk-averse response to the standard-only format might result from the fact that it was the only condition that did not contain a ladder or other visual representation of exposure levels. In the absence of a ladder, people lacked "locational" information about how many rungs above or below the standard their level was. In the other formats, by contrast, the risk ladder provided cues about the range of risks that might be expected from radon or asbestos, cues that may have reassured subjects about their assigned levels. Such locational cues may be extremely important in determining people's responses to risk magnitude information.

The validity of this speculation could not be tested in Phase One because there were several differences between the standard-only condition and the other formats (including the presence or absence of risk probability information, risk comparisons, and explicit action advice). Experiment I was therefore designed to test the idea that simply adding an exposure ladder to the standard-only format would affect perceived risk and related variables in the direction of reduced risk aversion. (For figures showing the Experiment I formats, see Appendix A.)

The standard-only format was replicated from Phase One, but this time it was compared to a new format that had not been tested previously. The new format contained a ladder of possible test results (but no information on the risk associated with those results) together with the information about the standard.

Experiment II. The second experiment explored two hypotheses developed to explain some perplexing Phase One results, together with a third, more conventional hypothesis. (For figures showing all Experiment II formats, see Appendix B.)

The Locational Hypothesis. The first idea to be tested had been labeled the "locational" hypothesis in Phase One. The focus in Phase One was on the information provided in the final page of the test brochure: a dichotomous government standard, mortality information for different exposure levels, comparisons to smoking risks, mitigation advice for different levels, etc. Except for the standard-only condition and one graphic display condition, all the formats included an "exposure ladder" on which the information to be provided in that treatment was arrayed. In all these cases, subjects assigned a low hypothetical test result found their result low on the exposure ladder and, hence, low on the page; those assigned a result near the standard found it in the middle of the page; those assigned a high result found it near the top of the page.

Perhaps the most important finding in Phase One was the failure of any of the seven formats to help subjects sufficiently appreciate that the lowest radon reading was 25 times as risky as the lowest asbestos reading, and the highest radon reading was 25 times as risky as the highest asbestos reading. Though several formats proved useful in producing appropriate differences in response across the four levels for each hazard, no format was efficacious in producing appropriate differences in response between the two hazards. In other words, where risk was proportional to location (within hazards), several formats worked well; where risk was not proportional to location (between hazards), no format worked well.

"Why were all formats able to produce a <u>level</u> effect while no format was able to produce an appropriately large <u>hazard</u> effect?" the Phase One report asked. It answered with the hypothesis that "people were responding to the position of their test result on the exposure level ladder in the brochure":

> This "locational hypothesis" asserts that the within-hazard variations with test result were chiefly a product of the placement of the level on the page, a purely arbitrary "locational" factor, and not an appreciation of the magnitude of the risk. The locational hypothesis neatly accounts for the failure to achieve an appropriate response to the difference between the two hazards. There were no locational differences between radon and asbestos; a particular level of radon (in picoCuries

per liter) was located at about the same point on the risk ladder as the comparable level of asbestos (in fibers per liter), even though the radon exposure represented a 25-fold higher risk. Thus the study's success in achieving a level effect and its failure to achieve a hazard effect can both be explained by the locational hypothesis.

The locational hypothesis suggests that changing the vertical position at which a given test result appears on the exposure ladder (i.e., low, middle, or high on the page) should affect perceptions of risk, even though the actual level of risk is held constant.

The Test Magnitude Hypothesis. A second possible explanation for the Phase One failure to find an adequate hazard effect focuses on the magnitude of the numbers in which the radon and asbestos tests were expressed. The four hypothetical test results for radon (in pCi/l) and for asbestos (in f/l) were chosen in Phase One to be roughly the same size numbers (rather than the same size risks), arrayed around the action guidelines of 4 pCi/l for radon and 3 f/l for asbestos. The levels used for radon were 0.8, 3.5, 4.5, and 24 pCi/l, while the levels used for asbestos were 0.8, 2.5, 3.5, and 24 f/l. If Phase One subjects responded to neither locational cues nor risk information, but rather to the size of the raw numbers they were given to indicate their test result, their responses to radon and asbestos would be very similar. This "test magnitude" hypothesis, in other words, can also account for the Phase One findings.

This second hypothesis suggests that the magnitude of the numbers on the exposure scale affects perceived risk. For example, if an asbestos exposure level of 15 f/l were converted into a level of 450 f/cubic foot, then it would be perceived as more risky simply because of the larger numerical value, even though the objective risk remained constant.

The Risk Hypothesis. For contrast with the hypothesized locational and test magnitude effects, the second experiment also considered a more obvious notion, that increasing the objective risk level would result in an increase in the perceived risk, even when the position of the test result on the page and the magnitude of the test numbers were both held constant. Experiment II was designed to permit comparisons of the size of the locational effect, the test magnitude effect, and the risk effect.

Experiment III. The third experiment explored two new hypotheses and retested two old hypotheses from Experiment II. (For figures showing all Experiment III formats, see Appendix C.) The first new hypothesis was the idea that simultaneous presentation of exposure and risk information for two hazards (radon and asbestos) on the same risk ladder would result in greater appreciation of the difference in risk between the two hazards than separate presentation of the information. At the levels commonly encountered, radon represents a considerably greater risk than asbestos, a fact that the public has not generally appreciated. Perhaps showing the two hazards and their associated risks together on the same page might drive home the point, leading to increased perceptions of risk for radon and decreased perceptions of risk for asbestos (vis-à-vis the separate presentation of the two hazards).

The second new hypothesis concerned the presence of a "hazard" effect independent of risk -- the idea that radon and asbestos, because of their different histories and characteristics, might produce differences in perceived risk even when the actual risk, test magnitude, and position on the page were held constant. In the expectation that such a hazard effect would emerge, questionnaire items on various hazard characteristics (dread, lethality, naturalness, etc.) were added to the study so that the ability of these characteristics to explain hazard effects could be assessed.

The third and fourth hypotheses for Experiment III were retests of the locational and risk effects.

CHAPTER TWO

METHODS

Overall Research Plan

The general research paradigm replicated that of Phase One. That is, subjects were asked to assume a particular hypothetical home test result for either radon or asbestos, to read a brochure about the radon or asbestos hazard, and then to complete a series of questions dealing with their assessment of the risk represented by their assigned level. Both the assigned test result and the format of the interpretive brochure were systematically varied, and the results were analyzed in terms of the effects of different format characteristics on perceptions of risk. The Phase Two experiments differed from those in Phase One in that they utilized new formats in order to test the hypotheses described in the Introduction.

Because of the possibility that some study participants would already know about the recommended 4 pCi/l action guideline for radon – and that this knowledge would affect their responses to their hypothetical radon test result – most of the Phase Two research made use of the asbestos hazard instead. This was especially important because the formats tested in Experiments II and III of Phase Two did not include an action guideline.

Materials and procedures that were common to all three Phase Two experiments are described here. The specific variations used for each of the separate experiments will be discussed in detail in the methods section for each experiment.

Sample. As in Phase One, randomly selected central New Jersey homeowners were recruited as volunteers. The specific population of interest was all homeowners listed in the New Brunswick, New Jersey telephone directory. This directory includes many adjoining communities in Middlesex County, New Jersey, varying widely in ethnic, income, and educational characteristics. The research was limited to homeowners because it was thought that questions concerning the need for home mitigation would be less hypothetical for this group than for apartment dwellers or renters.

Risk communication brochures. Four-page brochures presenting information from government publications about the nature of the risk from asbestos or from radon were prepared. The first three pages of each brochure, containing general information about the hazard, were the same across all conditions; for Experiment III the length was cut to two pages (see Appendices). The final page, referring to the size of the risk for different exposure levels, was the format being tested, and differed according to experimental condition. The simplest format, referred to as the "standard-only" format, only described the level at which government agencies recommended mitigation. All the other formats contained a vertical ladder representing different hazard exposure levels. Experimental variations included the risk levels represented, the degree to which the ladder extended downward or upward beyond the levels assigned to subjects, and the units in which exposures on the ladder were expressed.

Although there is an EPA recommended action level for radon (4 picoCuries per liter), there is none for asbestos. Previous research (Phase One) had created an asbestos "action level" based on EPA guidelines for schools, and this guideline was used for Experiment I in Phase Two as well. In the other two Phase Two studies, however, no recommended action levels were specified; the focus was on examining how homeowners interpret or use risk data.

Feedback questionnaire. Subjects also received an evaluation questionnaire (see Appendices), adopted with little modification from the Phase One questionnaire. It addressed three response dimensions, as follows:

Demographics. To measure demographic variables, questions were asked about age, sex, and educational level.

Audience Evaluations. Four questions were used to obtain the subjects' evaluations of the risk communication brochure. The first item assessed the difficulty of the brochure. Choices ranged from 1 = very difficult to 4 = very easy. The second item asked subjects to rate how helpful the brochure was in understanding the hazard, with values ranging from 1 = didn't help to 4 = very helpful. Subjects were also asked to rate how much information was included in the brochure (1 = much too little to 5 = much too much). Finally, subjects were asked how confident they were that they understood the risk from the hazard after reading the brochure. Choices ranged from 1 = uncertain to 4 = very certain. For the most part, there was no reason to expect that the format variations tested in the present experiments would affect audience evaluation, but these variables were included in case of unanticipated effects. Subjects' evaluations of the difficulty and helpfulness of materials are not of course reliable measures of how well they were actually able to use the materials.

Risk Responses. The key questionnaire items were of course the risk-related response measures. A total of eight questions were asked that bore on various aspects of subjects' perceptions of the risk. A ninth item was a composite index of perceived threat created from four of the eight questions (numbers 5-8 below).

(1) *Mitigation Difficulty*. The perceived difficulty of mitigation was measured with a single 4-point scale, ranging from 1 = very easy to 4 = very difficult. (The wording of the question was changed in Experiment III.) The experimental conditions did not vary in the information they provided about mitigation difficulty, and this question was included mainly to check for the possibility that effects on perceived risk would also affect perceptions of mitigation difficulty. Perceptions of mitigation difficulty also provide background for understanding mitigation decisions. No effects of format differences on ratings of mitigation difficulty were found in any experiment. Therefore, although this variable will be included in the tables, it will not be discussed in the text.

(2) *Acceptable Exposure Levels.* Subjects were asked at what level of exposure in their main living area they would feel satisfied, so that they would not spend more money trying to get the level even lower. If a particular way of presenting information increases perceptions of risk, it might also lead people to request a lower level. Twelve choices were provided. When the test result was expressed in fibers per liter, the choices ranged from 0 f/l to 350 f/l. When the test result was expressed in fibers per deciliter, the choices ranged from 0 f/dl to 350 f/dl. When the test result was expressed in fibers per cubic feet, the choices ranged from 0 f/cu. ft. to 10,500 f/cu. ft. This variable was not included in Experiment III.

(3) *Illness Probabilities.* One question was asked about the potential for illness from the subjects' hypothetical test result levels. In Experiment I, where no probability information was included, this question shows how people infer risk from a standard or a standard plus ladder. In Experiments II and III, where probability information was incorporated into the formats, this question was conceptualized as a measure of comprehension rather than as a measure of perceived risk. In Experiments I and II, a 9-point scale was used, with alternate points labeled: "no chance," "1 in 1000," "1 in 100," "1 in 10," and "certain." (Hypothetical risks lower than 1 in 1000 were not used in the study.) Percentage equivalents were also given. The response scale for illness probabilities was simplified in Experiment III. All choices were given in deaths per thousand and all the points were labelled. Thirteen choices were given, and the correct responses (5 in 1000 for low-risk subjects and 120 or 125 in 1000 for high-risk subjects) were among these choices.[6]

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[6]Subjects in Experiment II were often inaccurate in choosing the illness probability posed by their hypothetical test result, but it was unclear whether they had difficulty determining the correct probability from the information provided or had difficulty finding that probability on the feedback question. The revisions to the scale in Experiment III made the correct interpretation much easier to determine. In the revised response scale, all choices were in deaths per 1000 because the last brochure page gave the risk in this unit. Also, the correct answer was one of the labeled responses, so that interpolating to find the right answer – as had been necessary in Experiment II – was no

Errors were measured by the number of steps between a subject's response and the correct answer, with all steps being given equal weight. In other words, the answers to this question were analyzed as if the scales had equal intervals (1 to 9 in Experiments I and II; 1 to 13 in Experiment III) rather than in terms of the actual probabilities listed. If the numerical probabilities had been used instead, the size of each subject's error would depend not only on the number of steps away from the correct answer but on the portion of the scale where the correct answer lay, since the difference in probability between adjacent steps grows larger as one moves toward higher probabilities.

(4) *Mitigation Intentions.* Subjects were asked how likely they would be to spend $1000 in order to reduce their level of asbestos or radon close to zero. The choices ranged from 1 = definitely would take action to 5 = definitely would not. This is the closest the study design could come to studying actual behavior.

(5) *Perceived Likelihood.* A 7-point scale assessed subjects' perception of the likelihood of harmful effects from their hypothetical test results. The scale values ranged from 1 = no chance to 7 = certain.

(6) *Perceived Seriousness.* A 6-point scale assessed perceived seriousness, with values ranging from 1 = no risk to 6 = very serious risk.

(7) *Concern.* Concern was measured using a 5-point scale ranging from 1 = not at all concerned to 5 = extremely concerned.

(8) *Fear.* Fear was measured using a 5-point scale ranging from 1 = not at all frightened to 5 = extremely frightened.

(9) *Composite Index of Perceived Threat.* The four items pertaining to perceived likelihood, perceived seriousness, concern, and fear were added together to form a composite index of perceived threat (range = 4-23). This was done in both the Phase One and the Phase Two research to develop a more sensitive and reliable

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longer required.

response measure, and because these four variables were highly inter-correlated (with inter-item correlations ranging from .57 to .76), suggesting they tapped the same general dimension. (Other items that might have been included in the index variable, such as illness probability estimates or mitigation intentions, had somewhat lower correlations with items 5-8.) Internal consistency as assessed by coefficient alpha was .84 for the composite index.

Recruitment procedure. As in the Phase One research, potential subjects were recruited by telephone, with numbers selected randomly from directory listings. They were screened to ensure that they were 18 or older, were homeowners, and had not tested their homes previously for radon or asbestos. (Those who had tested for radon were included in the sample but were assigned only to asbestos conditions.) Recruiters alternatively asked to speak with male and female residents to balance the sex of subjects.

A total of 8,024 potential subjects were reached by telephone and asked to participate in one of the three experiments. Of these, 2,431 (30.3%) agreed and were sent questionnaires and test materials. Of those who agreed, 1,418 (58.3%) actually returned their completed questionnaires. At least two follow-up telephone calls were made to encourage cooperation by people who had agreed to take part.

Experiment I Methods

Appendix A shows the brochures, formats, and questionnaires for Experiment I.

Design. The design of the first experiment was a 2 x 4 (format x level) between-subjects design. The four hypothetical test result levels were the same as in Phase One (0.8, 2.5, 3.5, and 24.0 f/l), as was the asbestos action standard of 3.0 f/l.[7] As in Phase

[7]No standard or guideline for home asbestos currently exists. The 3.0 f/l level used here is derived from a U.S. Environmental Protection Agency standard that does exist for schools. The weekly acceptable school exposure is the product of the .1 f/cubic centimeter maximum acceptable exposure level and the assumed school exposure duration of 40 hours per week. Home effects are typically based on an assumed exposure of 126 hours per week (18 hours per day). Converting the maximum accept-

One, the test result levels were symmetric about the action guideline, with two near it (one slightly below and one slightly above) and two far away (one well below and one well above).

Subjects. Subjects were 435 homeowners recruited from Middlesex County. Of 2,295 potential subjects reached by telephone, 706 (30.8%) agreed to participate in the study. Of those who agreed, 60.2% returned a completed questionnaire.

Formats. The standard-only format was unchanged from Phase One. It stated that "A home level of 3 f/l or above corresponds to the risk at which EPA requires action in schools and public buildings." No other information about the risk of different levels was provided. The new standard+ladder format added an exposure ladder. The exposures on the ladder ranged from .1 f/l at the bottom to 100 f/l at the top. The suggested action level of 3.0 f/l was at the middle of the scale and was identified by a large arrow containing the text: "A home level of 3 f/l or above corresponds to the risk at which EPA requires action in schools and public buildings."

Procedure. Homeowners who agreed to participate were randomly assigned to one of the eight format x level conditions and mailed the appropriate test brochure format, "imaginary" test result level, and feedback questionnaire.

Experiment II Methods

Appendix B contains the brochures, formats, and questionnaires used in Experiment II. Tables 1 and 2 compare the four Experiment II formats on a single page.

Design. The second experiment used a single-factor between-subjects design with four levels of the treatment condition (format). Each format included an exposure ladder with risk information (extra cancer deaths per 1000 people exposed) and smoking comparisons at several points along the ladder.

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able school exposure to an equal home exposure yields an "acceptable" home level of about 3 f/l.

TABLE 1

Experiment II Format Conditions

Format	Test Result Magnitude	Test Result Units	Objective Risk (deaths/1000)	Location on Page
Base	15	fibers/liter	3.0	Low
Displaced	15	fibers/liter	3.0	High
High Test Magnitude	450	fibers/cubic ft	3.0	Low
High Risk	15	fibers/deciliter	30.0	Low

TABLE 2

Experiment II Formats
(X indicates position of test result on exposure ladder)

Base	Displaced	High Test Magnitude	High Risk
-	-	-	-
-	-	-	-
-	15 - X	-	-
-	-	-	-
-	-	-	-
-	-	-	-
15 - X	-	450 - X	15 - X
-	-	-	-
-	-	-	-
fibers/liter	fibers/liter	fibers/cubic ft	fibers/deciliter

Four versions were used. (1) For the "Base" scale, asbestos exposure levels were expressed in terms of fibers/liter. (2) The "Displaced" scale used the Base scale ladder shifted upwards, so that the same test result would appear higher on the page by about half the length of the scale. (3) The "High Test Magnitude" scale was identical to the Base scale except that exposure levels were expressed in terms of fibers per cubic foot. With this change in units, the labels on the exposure scale were 30 times larger than when the labels were expressed in fibers per liter, though the risk was unchanged. (4) The "High Risk" scale, finally, used the same numbers to describe exposure levels as the Base scale, but with units of fibers per deciliter. Thus, the risk at each level (in deaths per 1000 and in smoking comparisons) was ten times greater than the comparable risk on the Base scale.

Subjects in the first three conditions (who received the Base, Displaced, or High Test Magnitude formats) were assigned a hypothetical test result equivalent to a cancer risk of 3.0 deaths per 1000 persons. Subjects in the fourth condition (who received the High Risk format) were assigned a test result equivalent to a risk level of 30 deaths per 1000 – ten times the risk in the first three conditions.

Three key comparisons were planned to analyze the effects of the experimental variations:

- <u>Base versus Displaced</u> – the effects of location (a variation of half the length of the ladder).
- <u>Base versus High Test Magnitude</u> – the effects of the size of the numbers in which the test result was expressed (a 30-fold difference).
- <u>Base versus High Risk</u> – the effects of actual risk (a 10-fold difference).

Two additional comparisons compared the sizes of the preceding effects:

- <u>Displaced versus High Risk</u> – the relative effects of a half-page displacement of the risk scale as compared to a 10-fold variation in risk.
- <u>High Test Magnitude versus High Risk</u> – the relative effects of a 30-fold variation in test numbers as compared to a 10-fold variation in risk.

Care was taken to hold as many features of the formats as possible constant, while manipulating only the position (Base or Displaced), numerical magnitude (Base or High Test Magnitude) or risk level (Base or High Risk) of the test result. (See Table 1, p. 38.)

Subjects. Subjects were 449 homeowners recruited from Middlesex County. A total of 2,488 persons were reached by telephone and were qualified; of these, 753 (30.3%) agreed to participate in the study. Of those who agreed, 59.6% returned a completed questionnaire.

Formats. The test of the locational hypothesis depends on the Base scale and the Displaced scale; location on the page was varied, while units of exposure magnitude and actual risk were held constant. The Displaced scale used the same units as the Base scale (f/l), but was shifted so that the test result of 15.0 f/l appeared about three quarters of the way up the page, compared to only one-quarter of the way up the page on the Base scale.. Because the Displaced scale was shifted upwards, the range of values shown on the exposure ladder was different. The Base scale exposure levels ranged from 3.5 to 1500 f/l, while the Displaced scale had exposure levels ranging from .15 to 75 f/l. At any particular height on the page, the risk on the Base scale was about 23 times the risk on the Displaced scale. If a locational effect exists, subjects should have seen their risk as greater in the Displaced condition than in the Base condition because their level appeared higher on the page.

The test of the test magnitude hypothesis used the Base scale and the High Test Magnitude scale. The two were identical in that the hypothetical test result was in the same relative position (one-quarter of the way up the page) and represented the same cancer risk (3.0 deaths per 1000). But the units on the exposure ladder were changed from fibers/liter in the Base scale to fibers/cubic foot in the High Test Magnitude scale. Because a cubic foot is about 30 times the volume of a liter, the corresponding exposure ladder numbers were 30 times larger than those on the Base scale. The numeric labels on the exposure ladder in the High Test Magnitude condition ranged from 105 to 45,000, while on the Base scale they ranged from 3.5 to 1500. The assigned hypothetical level in the

High Test Magnitude condition was 450 fibers/cubic foot, compared to 15 fibers/liter in the Base condition. If a test magnitude effect exists, participants should have rated the same actual exposure as riskier in the High Test Magnitude condition than in the Base condition.

The fourth condition, High Risk, served as a benchmark for assessing the size of the locational and test magnitude effects. In addition, it provided an important test of the extent to which subjects are responsive to objective risk data when such cues as the position on the page and the numerical size of the test result are held constant. The High Risk condition had only one change from the Base condition. The exposure ladder was expressed in fibers/deciliter rather than fibers/liter. Since the numbers were the same as in the Base condition, the risk magnitudes were ten times as great. Thus, the fourth condition used a hypothetical test result of 15.0 f/dl – ten times the exposure level (and risk) of the other three conditions. The position of this test result on a ladder ranging from 3.5 to 1500 f/dl was the same as the position of the Base scale reading of 15.0 f/l on a ladder ranging from 3.5 to 1500 f/l. If subjects responded appropriately to risk level, they should have rated the risk as significantly higher in the High Risk condition than in the Base condition, despite the absence of locational or numerical cues to the difference in risk.

Procedure. Participants were randomly assigned to one of the four format conditions and mailed the appropriate test brochure format, an "imaginary" asbestos test result, and a feedback questionnaire.

Experiment III Methods

Appendix C contains the brochures, formats, and questionnaires used in Experiment III. Tables 3 and 4 compare all five formats on a single page.

Design. The third experiment used a single-factor between-subjects design with five levels of the treatment condition (format).

The first condition (Joint) presented radon and asbestos exposures and risk information on the same page. The risk levels employed for the two hazards were different. The asbestos test result assigned to all subjects in this condition was 25 f/l, equivalent to a risk

TABLE 3

Experiment III Format Conditions

Format	Hazard	Test Result Magnitude	Test Result Units	Objective Risk (deaths/1000)	Location on Page
Joint	Asbestos	25	fibers/liter	5	Low
Joint	Radon	25	picoCuries/liter	125	High
Base Radon	Radon	25	picoCuries/liter	125	High
Base Asbestos	Asbestos	25	fibers/liter	5	Low
High Risk Asbestos	Asbestos	60	fibers/deciliter	120	High
Displaced Asbestos	Asbestos	25	fibers/liter	5	High

TABLE 4

Experiment III Formats
(X indicates position of test result on exposure ladder)

Joint		Base Radon	Base Asbestos	High Risk Asbestos	Displaced Asbestos
Asbestos	Radon	Radon	Asbestos	Asbestos	Asbestos
-	-	-	-	-	-
-	-	-	-	-	-
-	25 - X	25 - X	-	60 - X	25 - X
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
25 - X	-	-	25 - X	-	-
-	-	-	-	-	-
-	-	-	-	-	-
fibers/ liter	picoCuries liter	picoCuries/ liter	fibers/ liter	fibers/ deciliter	fibers/ liter

of 5 deaths per 1000, while the radon test result was 25 pCi/l, equivalent to a risk of 125 deaths per 1000. The full range of the risks shown on the page extended from a minimum of 1.5 deaths per 1000 to a maximum of 400 deaths per 1000. On this scale, the asbestos test result appeared about one-fourth of the way up the ladder, while the radon test result appeared about three-fourths of the way up the ladder. Thus, a physical distance between the results of about half the length of the scale represented a 25-fold difference in risk.[8]

The second and third conditions (called Base Radon and Base Asbestos, respectively) were simply separate presentations of the same information presented jointly in the Joint format. The Base Radon format presented the radon information, while the Base Asbestos format had the asbestos information. Location, test magnitude, and risk were all unchanged from the simultaneous presentation condition.

The fourth condition (High Risk Asbestos) presented the asbestos hazard only, but with a risk level roughly equal to the radon risk in the Joint and Base Radon formats. The scale for the High Risk Asbestos condition was manipulated so that the asbestos test result appeared in the same location as the radon test result in the Joint and Base Radon conditions, roughly three-quarters of the way up the page. The labels on the asbestos exposure ladder in this format had the same numerical values as the labels on the asbestos ladders in the Joint and Base Asbestos formats, but the unit of exposure was fibers/deciliter instead of fibers/liter. This meant that the risks in the High Risk Asbestos format were ten times higher than the corresponding risks in the Joint and Base Asbestos formats. The hypothetical test result used in this condition was 60 f/dl. This yielded a risk level of 120 deaths per 1000, essentially the same as the radon risk in the Joint and Base Radon formats.

Finally, the fifth condition (Displaced Asbestos) was a vertically shifted version of the Base Asbestos scale. The scale was displaced so that the low asbestos risk of 5 deaths

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[8]The Joint format was created in two forms, with radon levels first in one version and asbestos levels first in the other. This variation had no effects on responses and will not be discussed further.

per 1000 associated with the 25 f/l test result would appear physically on the scale in the same position as the high radon and high asbestos test results, about three-fourths of the way up the page.

Four comparisons were of primary interest, as follows.

- *Comparison of the Joint, Base Radon, and Base Asbestos formats.* This comparison tests the first new hypothesis – that a simultaneous asbestos/radon risk ladder yields stronger between-hazard differences than separate risk ladders for each hazard.
- *Comparison of the Base Radon and High Risk Asbestos formats.* This comparison tests the second new hypothesis – that people respond differently to radon than to asbestos even when risk and location on the page are held constant.[9]
- *Comparison of the Base Asbestos and Displaced Asbestos formats.* This comparison retests the locational hypothesis – that when risk, test magnitude, and hazard (in this case, asbestos) are held constant, people respond to locational cues about the seriousness of the risk.
- *Comparison of the High Risk Asbestos and Displaced Asbestos formats.* This comparison retests the risk hypothesis – that when location and hazard (asbestos) are held constant, people respond to data about the size of the risk.[10]

As in Experiment II, care was taken to hold as many features of the formats constant as possible. The features that were systematically varied are displayed in Table 3, p. 43.

Subjects. Subjects were 534 homeowners recruited from Middlesex County. A total of 3,241 potential subjects were contacted; of these, 972 (30.0%) agreed to participate in

[9]Test magnitude varied between the two conditions, but only by a factor of 2.4. Inasmuch as a much larger variation in test magnitude produced no effects in Experiment II, the third experiment was interpreted as if test magnitude also had been held constant.

[10]Once again test magnitude varied only by a factor of 2.4, and was considered invariant. See the previous footnote.

the study. Of those who agreed, 54.9% returned a completed questionnaire.[11]

Formats. The formats were as described above.

Feedback questionnaire. The feedback questionnaire from Experiments I and II was modified somewhat. (See Appendix C for a copy of the Experiment III questionnaire.) Several less crucial items were deleted or revised[12] to accommodate five scales derived from the work of Slovic, Fischhoff, and Lichtenstein (1985). These 7-point rating scales assessed hazard dimensions that might account for differences in perceived risk between asbestos and radon.

- *Mitigation difficulty.* The Slovic et al. version of the mitigation difficulty question replaced the one used in previous studies. Choices ranged from 1 = very easy to reduce to 7 = very difficult to reduce.
- *Dread.* This question assessed the degree to which people dread the negative health consequences associated with radon or asbestos exposure. Choices ranged from 1 = calm reaction to 7 = dread risk.
- *Lethality.* Subjects were asked how likely they thought it was that illness resulting from radon or asbestos exposure would be fatal. Choices ranged from 1 = certain not to be fatal to 7 = certain to be fatal.
- *Unfamiliarity.* Subjects were asked whether radon or asbestos was a familiar risk or a novel risk. Choices ranged from 1 = old to 7 = new.

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[11]The completion rate was somewhat lower than it had been in Experiments I and II. Because of the extra effort required to read two brochures and complete two questionnaires in the Joint presentation condition, it appeared possible that the decline in the completion rate was due to this condition. A breakdown of the Experiment III data showed, however, that the return rate for the Joint condition was only marginally lower than for the separate presentation conditions (51.3% and 55.9%, respectively).

[12]For example, two of the four original evaluation measures -- amount of information and uncertainty -- were dropped.

Naturally occurring (vs. man-made). Choices ranged from 1 = all man-made to 7 = all natural.

Procedure. Participants were randomly assigned to one of the five format conditions and mailed the appropriate test brochure format, an "imaginary" radon or asbestos test result (or both), and a feedback questionnaire.

CHAPTER THREE

RESULTS

Results are presented in five parts. First, distributions of the demographic variables and their associations with risk perception measures are given. Second, responses on the audience evaluation variables are summarized. In the final three parts, the results of principal interest, the analyses of treatment effects, are described separately for each experiment.

The criterion level for statistical significance was set at .05 for all tests. The sample sizes for the experiments were large enough to permit adequate sensitivity. The statistical power to detect the conventional "medium" effect size of a ½ standard deviation difference between two means was .90 to .95 for most tests. The power to detect a "large" effect size of a full standard deviation difference between two means was .99 or higher for most tests. In other words, the experiments were quite sensitive to effects of meaningful sizes.[13]

Five risk perception measures were considered. The first and most sensitive was the composite measure of perceived threat, the sum of four separate questions. The four other risk-related variables were: intentions to mitigate; estimates of the numerical probability of illness from the subjects' hypothetical test results; the perceived difficulty of mitigation; and

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[13]See J. Cohen, Statistical power analysis for the behavioral sciences, 2nd ed. Hillsdale, NJ: Lawrence Erlbaum, 1988.

the highest exposure level at which subjects would feel satisfied. The last two questions were not asked in Experiment III, leaving only three dependent variables.

Demographic Characteristics

Distributions of demographic variables. A total of 8,024 potential subjects were contacted; of these, 2,431 agreed to participate and 1,418 completed and returned usable questionnaires. Table 5 shows that the distributions of the three demographic variables included in these experiments – age, education, and sex – were consistent across studies.

- *Age.* The mean age of subjects in Experiments I, II, and III ranged from 43.78 to 44.60 years.
- *Educational level.* Subjects were quite well educated. Over 70% of the subjects reported their educational levels as "some college" or higher, and more than 15% of the total sample reported having a graduate degree.
- *Sex.* Women comprised roughly 52% of the sample.

Comparisons with 1980 census data for the municipalities from which the Phase Two samples were drawn indicate that study participants were substantially better educated than non-participants; 76.2% of subjects had some education beyond high school, compared to 27.0% of the census population. On age and sex, on the other hand, the sample and the census population were well matched; 24.7% of subjects and 24.3% of the census population were over 55, while 48.2% of subjects and 49.4% of the census population were male.

Relationships between demographic variables and response variables. The associations between the demographic variables and the perceived risk measures were tested by regression analyses in which age, education, and sex were each examined separately and treated as continuous variables. If the associations proved significant, the demographic variables were included later as covariates when tests of format effects on the perceived risk measures were carried out. This use of covariates removes bias caused by random differences in the distribution of demographic variables across conditions and improves the sensitivity of the tests of treatment effects.

TABLE 5

Distributions of Demographic Variables

	Experiment		
	I	II	III
Age	Percent	Percent	Percent
Under 20	1.7	1.8	1.6
20 - 29	10.7	11.8	13.1
30 - 39	29.4	29.0	29.8
40 - 49	27.7	26.0	19.3
50 - 59	14.1	15.8	19.1
60 - 69	11.7	14.0	12.5
70 - 79	4.6	1.3	4.4
80 - 89	0.0	0.5	0.2
Mean	44.04	43.78	44.60
SD	13.25	12.90	13.82
N	407	395	497
Educational Level	Percent	Percent	Percent
Some elementary school	0.0	0.0	0.2
Finished elementary school	0.7	0.3	0.2
Some high school	2.2	2.3	2.4
Finished high school	23.7	19.5	20.0
Some college	21.0	16.8	18.8
Finished 2-year college	6.3	8.0	9.2
Finished 4-year college	23.7	23.3	24.0
Some graduate study	6.1	8.8	10.6
Graduate degree	16.3	21.1	14.6
Sex	Percent	Percent	Percent
Men	50.1	46.4	48.1
Women	49.9	53.6	51.9

None of the associations between a demographic variable and a response measure was significant across all three experiments. Because the relationships between demographic variables and risk response variables were generally small and sometimes contradictory, no effort was made to interpret these findings substantively. Table 6 summarizes the tests of these associations and shows the direction of all relationships that proved significant (16 out of 39 tests).

Audience Evaluation

As expected, no significant format effects on perceived difficulty, helpfulness, amount of information, or uncertainty were found in the three experiments, other than would be expected by chance given the number of tests conducted. Consequently, Table 7 presents means and standard deviations on the audience evaluation questions for all three experiments but does not break down the results by format.

Brochure difficulty. Subjects found all the test brochures easy to read. The mean difficulty ratings ranged from 3.51 to 3.54 across experiments. The value 3 represented "fairly easy to understand" and the value 4 represented "very easy to understand."

Helpfulness of information. Subjects also found the brochures helpful. The mean helpfulness ratings ranged from 3.19 to 3.51. The value 3 represented "moderately helpful in understanding my test result" while the value 4 represented "very helpful in understanding my test result."

Amount of information in brochure. Subjects rated the amount of information provided to be "about right." Mean ratings were 2.81 in Experiment I and 2.88 in Experiment II on the five-point scale. The value 3 represented the choice "about right." Values under 3 indicated insufficient information.

Uncertainty in understanding of risk. Subjects felt they had a good understanding of the risk at their hypothetical test level. The mean rating for Experiment I was 1.86 on the four-point scale. The mean rating for Experiment II was 1.68. The value 1 indicated "very good understanding" and the value 2 indicated "good understanding."

TABLE 6

Significance and Direction of Associations Between Demographic Variables and Response Measures

	Response Measure					
	Perceived Threat		Mitigation Intentions		Illness Probability	
Covariate	F/(df)	Direction	F/(df)	Direction	F/(df)	Direction
			Experiment I			
Age	5.86* (1,358)	-	4.82* (1,395)	-	2.02 (1,327)	
Educational Level	0.01 (1,358)		4.33* (1,395)	+	2.23 (1,327)	
Sex	13.79** (1,358)	+	0.01 (1,395)		7.45** (1,327)	+
			Experiment II			
Age	4.45* (1,355)	-	14.83*** (1,360)	-	0.56 (1,386)	
Educational Level	0.01 (1,355)		0.23 (1,360)		1.69 (1,386)	
Sex	5.70* (1,355)	+	3.90* (1,360)	+	1.04 (1,386)	
			Experiment III			
Age	1.97 (1,562)		2.38 (1,576)		6.94** (1,586)	-
Educational Level	2.62 (1,562)		9.85** (1,576)	+	26.23*** (1,586)	+
Sex	0.02 (1,562)		1.45 (1,576)		1.06 (1,586)	

	Response Measure			
	Mitigation Difficulty		Acceptable Exposure Level	
Covariate	F/(df)	Direction	F/(df)	Direction
Experiment I				
Age	10.82** (1,386)	+	2.24 (1,382)	
Educational Level	3.66 (1,386)		0.95 (1,382)	
Sex	0.10 (1,386)		5.72* (1,382)	-
Experiment II				
Age	0.27 (1,352)		8.05** (1,327)	-
Educational Level	0.30 (1,352)		0.25 (1,327)	
Sex	0.03 (1,352)		4.70* (1.327)	-

* $p < .05$
** $p < .01$
*** $p < .001$

Mitigation difficulty and maximum acceptable exposure level were not included in Experiment III.

A "+" indicates that as the covariate increases so does the response measure. A "-" indicates an inverse relationship.

TABLE 7

Audience Evaluation Variables
(Means and Standard Deviations)

		Experiment	
Variable	I	II	III
Difficulty			
Mean	3.51	3.54	3.54
SD	0.57	0.53	0.56
N	410	399	593
Helpfulness			
Mean	3.19	3.51	3.46
SD	0.87	0.67	0.68
N	397	386	578
Amount of Information			
Mean	2.81	2.88	-
SD	0.54	0.42	-
N	395	390	-
Uncertainty in Understanding Risk			
Mean	1.86	1.68	-
SD	0.78	0.63	-
N	411	400	-

The last two items were not asked in Experiment III.

Format Effects on Risk Perception Variables: Experiment I

Experiment I examined the effects of the standard-only and standard+ladder formats with four hypothetical asbestos levels. (See Appendix A for the two formats.) It was hypothesized that the addition of a risk ladder would significantly reduce the perceived risk, particularly at the two hypothetical asbestos levels above the guideline of 3.0 f/l. Analyses of response measures were conducted using a 2 x 4 (format x level) design with appropriate demographic variables as covariates. Results for the full design are presented first, followed by a separate analysis for the high hazard levels (3.5 f/l and 24.0 f/l).

Full design analysis. Results of the analysis for the five response variables are given in Table 8.[14] Table 9 presents means and standard deviations. The least-squares means were adjusted for the particular covariates (age, educational level, and/or sex) that had proved to be related to the response measure in question. Four risk perception variables showed significant relationships to the assigned asbestos level, but only one of the four (the composite measure of perceived threat) showed a significant relationship to the format manipulation. (The level x format interactions were all nonsignificant.)

- *Composite measure of perceived threat.* There was a strong effect of asbestos level on the perceived threat, $F(3,359) = 52.77$, $p < .0001$. The higher the hypothetical asbestos level, the higher the composite risk index. The effect of format was also significant, $F(1,359) = 3.89$, $p = .05$. The mean composite risk rating for the standard-only format was 14.32, compared to 13.46 for the standard+ladder format. The format x level interaction was not significant, $F(3,359) = 0.80$, NS, indicating that the effect of format was roughly consistent across assigned asbestos levels. These results are apparent in Figure 1, which shows the relationship between the perceived threat

[14]As noted earlier, mitigation difficulty showed no significant effects in any experiment; it is included in the tables but not discussed in the text.

TABLE 8

Experiment I Analysis of Covariance of Response Measures by Format and Hypothetical Exposure Level

Source	Perceived Threat Index F/(df)	Perceived Threat Index Significance Level	Mitigation Intentions F/(df)	Mitigation Intentions Significance Level	Illness Probability F/(df)	Illness Probability Significance Level
Format	3.89 (1,359)	* (p = .05)	< 1 (1,396)	NS	< 1 (1,332)	NS
Level	52.77 (3,359)	****	20.97 (3,396)	***	27.98 (3,332)	***
Format x Level	< 1 (3,359)	NS	< 1 (3,396)	NS	1.18 (3,332)	NS

Source	Mitigation Difficulty F/(df)	Mitigation Difficulty Significance Level	Acceptable Exposure Level fibers/liter[a] F/(df)	Acceptable Exposure Level fibers/liter[a] Significance Level	Acceptable Exposure Level 1-12 scale F/(df)	Acceptable Exposure Level 1-12 scale Signif. Level
Format	< 1 (1,396)	NS	< 1 (1,396)	NS	< 1	NS
Level	< 1 (3,396)	NS	4.79 (3,396)	**	2.62	*
Format x Level	2.12 (3,396)	NS	< 1 (3,396)	NS	< 1	NS

Note: The demographic variables that proved significant in Table 6 were used in these analyses as covariates.

[a]Calculations were based on log-transformed values.

NS $p > .05$. * $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

TABLE 9

Experiment I Least-Squares Adjusted Means and Standard Deviations by Format and Hypothetical Exposure Level

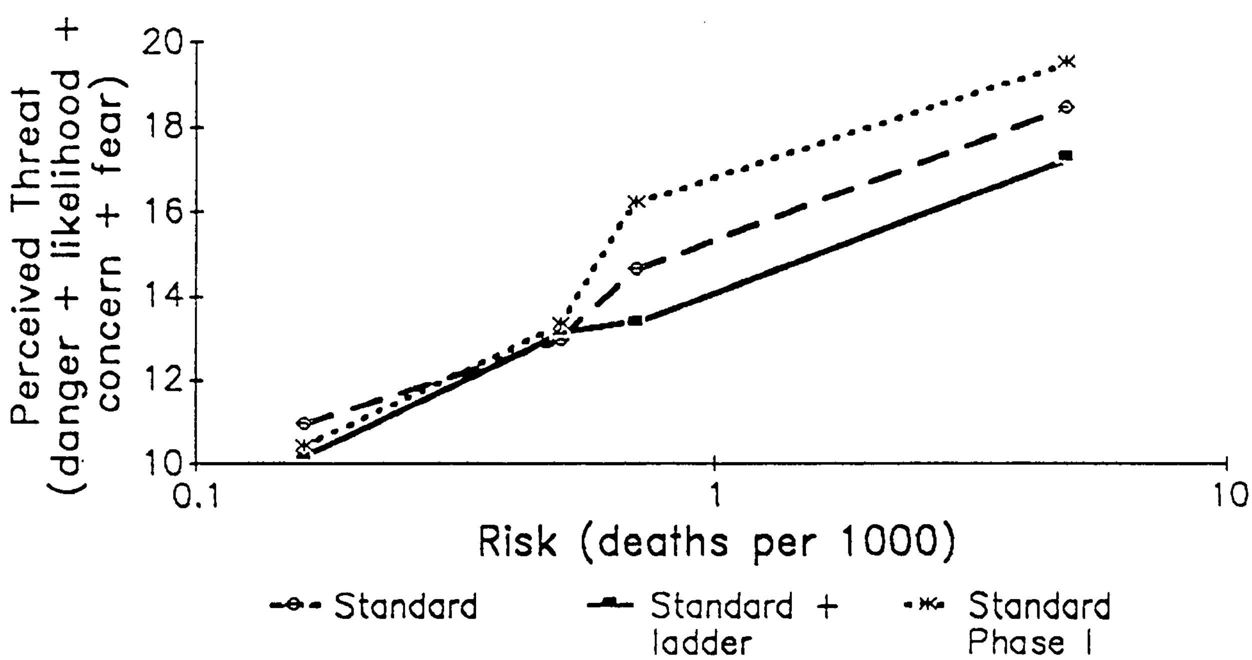
	Format					
	Standard-Only			Standard+Ladder		
Asbestos Level	Perceived Threat	Mitig. Intentions	Illness Prob.	Perceived Threat	Mitig. Intentions	Illness Prob.
0.8 f/l						
Mean	10.94	3.24	3.40	10.18	3.06	3.58
SD	3.70	1.97	2.00	3.69	1.14	2.01
N	40	45	36	46	51	45
2.5 f/l						
Mean	12.93	3.82	4.80	13.10	3.83	4.91
SD	3.70	2.20	1.98	3.69	1.11	1.89
N	53	58	50	50	55	49
3.5 f/l						
Mean	14.60	4.17	5.49	13.34	3.97	4.65
SD	3.69	1.12	2.06	3.69	1.10	1.99
N	45	49	41	48	54	44
24.0 f/l						
Mean	18.43	4.30	6.56	17.23	4.43	6.27
SD	3.69	1.04	2.01	3.69	1.12	1.94
N	41	45	37	46	49	39
Format Means						
Mean	14.32	3.88	5.06	13.46	3.82	4.85
SD	3.71	1.12	2.05	3.69	1.16	2.00
N	179	197	164	190	209	177

	Format			
	Standard-Only		Standard+Ladder	
Asbestos Level	Mitigation Difficulty	Acceptable[a] Exposure Level	Mitigation Difficulty	Acceptable[a] Exposure Level
0.8 f/l				
Mean	2.11	0.62	1.85	0.61
SD	0.71	2.61	0.70	2.22
N	45	45	51	51
2.5 f/l				
Mean	1.99	0.58	1.86	0.64
SD	0.68	2.69	0.70	2.80
N	58	58	55	55
3.5 f/l				
Mean	1.98	0.84	2.11	0.61
SD	0.69	3.19	0.69	2.83
N	50	51	52	52
24.0 f/l				
Mean	1.94	0.84	2.14	1.05
SD	0.70	1.13	0.70	3.32
N	40	45	48	48
Format Means				
Mean	2.01	0.71	2.00	0.78
SD	0.70	3.30	0.71	2.75
N	199	197	208	206

[a]Analyses performed on log-transformed data. Tables give inverse of mean of logarithms.

Figure 1

Experiment I
Effects on Perceived Threat of Adding a
Ladder of Exposure Levels to a Standard



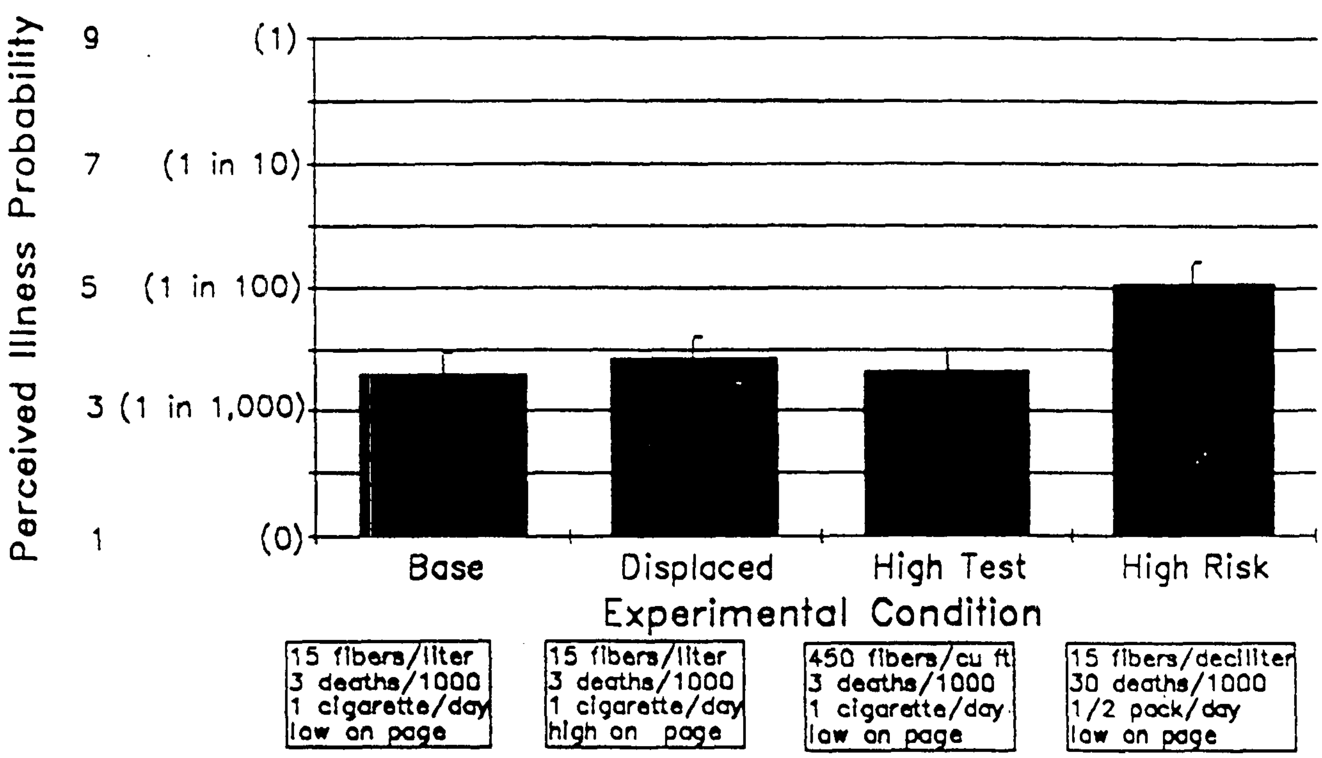
and asbestos level (expressed as mortality rates) for the standard-only and the standard + ladder formats.[15]

- *Mitigation intentions.* There was a significant effect of asbestos level on intentions to mitigate, $F(3,396) = 20.97$, $p < .001$. At the high hypothetical asbestos level, subjects experienced greater intentions to mitigate. The effect of format was not significant, $F(1,396) = 0.31$, NS, nor was there a significant format x level interaction, $F(3,396) = 0.57$, NS.
- *Illness probability.* The effect of asbestos level on the perceived likelihood of illness was significant, $F(3,332) = 27.98$, $p < .001$. At the high hypothetical asbestos level, the perceived probability of illness resulting from exposure was higher than at the low hypothetical asbestos level. The effect of format was not significant, $F(1,332) = 0.92$, NS, nor was the format x level interaction significant, $F(3,332) = 1.18$, NS. As Figure 2 shows, although level had a significant effect on illness probability estimates, the effect was smaller than the tenfold increase in actual risk. Subjects in the low-risk conditions estimated illness probability fairly accurately; those in the high-risk conditions estimated too low.
- *Acceptable exposure level.* The mean of the maximum acceptable level was under 2 f/l for all groups, well below the EPA guideline specified. Neither the effect of format, $F(1,396) = 0.06$, NS, nor the format x level interaction, $F(3,396) = 0.21$, NS, was significant. However, the hypothetical asbestos level did have a significant effect on the highest level subjects would accept, $F(3,396) = 2.62$, $p = .05$. Though the

[15]As seen in Figure 1, above the standard, perceptions of threat in the present research were lower than the perceptions of threat of subjects who had been assigned to the same format condition and asbestos levels in the Phase One research. The sharp "step increase" above the standard present in Phase One was not apparent in this new experiment. Further analysis showed a significant step in Phase One for the standard-only condition, but not for the condition that included a standard plus risk probability data and comparisons to smoking. In Phase Two, by contrast, no step was found for either the standard-only or the standard + ladder condition. These differences have no obvious explanations.

Figure 2

Experiment II
Effects of Location, Test Magnitude, and Risk Magnitude on Perceived Illness Probability



differences were small, subjects assigned the high hypothetical asbestos level considered a higher level to be acceptable.

Analysis for high-exposure subjects. Responses for test result levels exceeding the 3.0 f/l guideline were of particular interest because of the expectation that the greatest effect of a ladder might be to calm people who were slightly or moderately above the standard (see the Phase One data in Figure 1 (p. 60), indicating a sharp "step increase" in perceived threat above the standard). For this reason, 2 x 2 (format x level) analyses were conducted for the five response measures using only the 3.5 and 24.0 f/l asbestos levels. The results of the analyses of covariance are summarized in Table 10.

The results are not very different from those for the overall sample. The effect of an exposure ladder on perceived threat was stronger in Table 10 than in Table 8, but the format effects on the other four response variables were still nonsignificant.

In summary, the first experiment found that the addition of an exposure ladder had a modest effect on the perceived threat, but no effect on mitigation intentions, estimates of illness probability, estimates of mitigation difficulty, or acceptable exposure levels. Subjects in the standard + ladder condition, in short, did see the asbestos risk as somewhat less threatening than subjects in the standard-only condition, but the effect was small and was significant only with the most reliable response measure. The effect on perceived threat was somewhat stronger at high hypothetical asbestos levels than at lower levels, but the format x level interaction was not statistically significant.

Format Effects on Risk Perception Variables: Experiment II

Because Experiment II focused on three primary hypotheses (concerning the effects of location, the effects of test magnitude, and the effects of actual differences in risk) and two secondary hypotheses (comparing the first two effects with the third), the results were analyzed by means of planned comparisons, using Bonferroni's technique. Table 11 summarizes the results of these comparisons for the five response measures, and Table 12 presents least-squares adjusted means and standard deviations.

TABLE 10

Experiment I Analysis of Covariance of Response Measures by Format and Hypothetical Exposure Level (High Hazard Levels Only)

Source	Response Measure					
	Perceived Threat Index		Mitigation Intentions		Illness Probability	
	F/(df)	Significance Level	F/(df)	Significance Level	F/(df)	Significance Level
Format	5.75 (1,174)	* (p = .02)	0.08 (1,191)	NS	3.24 (1,156)	NS
Level	54.98 (1,174)	****	4.46 (1,191)	*	18.28 (1,156)	***
Format x Level	< 1 (1,174)	NS	1.42 (1,191)	NS	< 1 (1,156)	NS

Source	Response Measure			
	Mitigation Difficulty		Acceptable Exposure Level	
	F/(df)	Significance Level	F/(df)	Significance Level
Format	2.25 (1,191)	NS	< 1 (1,191)	NS
Level	< 1 (1,191)	NS	< 1 (1,191)	NS
Format x Level	< 1 (1,191)	NS	< 1 (1,191)	NS

Note: The demographic variables that proved significant in Table 6 were used in these analyses as covariates.

NS $p > .05$. * $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

TABLE 11

Experiment II Analysis of Covariance of Format Effects

Comparison	Response Measures: Perceived Threat Index F (df)/ Significance	Mitigation Intentions F (df)/ Significance	Illness Probability F (df)/ Significance
Overall Format Effect	F(3,356)=12.15 ****	F(3,387)=5.19 **	F(3,368)=17.62 ****
Primary Hypotheses			
Locational Effect: Base vs. Displaced	**	NS	NS
Test Magnitude Effect: Base vs. High Test Mag.	NS	NS	NS
High Risk Effect: Base vs. High Risk	**	NS	***
Secondary Hypotheses			
High Risk vs. Displaced	NS	NS	***
High Risk vs. High Test Mag.	***	***	***

	Response Measures		
	Mitigation Difficulty	Acceptable Exposure Level fibers/liter[a]	1-12 scale
Comparison	F (df)/ Significance	F (df)/ Significance	F (df)/ Significance
Overall Format Effect	F(3,395)=0.98 NS	F(3,384)=28.73 ****	F(3,384)=.83 NS
Primary Hypotheses			
Locational Effect: Base vs. Displaced	NS	NS	NS
Test Magnitude Effect: Base vs. High Test Mag.	NS	NS	NS
High Risk Effect: Base vs. High Risk	NS	***	NS
Secondary Hypotheses			
High Risk vs. Displaced	NS	***	NS
High Risk vs. High Test Mag.	NS	***	NS

Note: The demographic variables that proved significant in Table 6 were used in these analyses as covariates. Comparisons of pairs of conditions were conducted by use of Bonferroni's technique, with a significance criterion that controlled for the three post-hoc tests of primary importance.

[a]Calculations were carried out on log-transformed values (with responses of 0 fibers recoded as 0.075) because of the skewed distribution of responses and non-linear scale.

NS $p > .05$. * $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

TABLE 12

Experiment II Least-Squares Adjusted means
and Standard Deviations by Format

	Response Measure		
Format	Perceived Threat	Mitigation Intentions	Illness Probability
Base			
Mean	11.46	3.57	3.63
SD	3.46	1.19	1.53
N	90	98	92
Displaced			
Mean	12.95	3.68	3.89
SD	3.42	1.21	1.56
N	94	101	95
High Test Magnitude			
Mean	10.58	3.29	3.67
SD	3.43	1.19	1.53
N	93	99	93
High Risk			
Mean	13.24	3.95	5.08
SD	3.43	1.17	1.53
N	85	95	92

Format	Mitigation Difficulty	Acceptable Exposure Level fibers/liter[a]	Acceptable Exposure Level 1-12 scale
Base			
Mean	1.93	0.67[b]	3.90
SD	0.71	8.33	2.81
N	91	90	90
Displaced			
Mean	2.04	0.51[b]	3.62
SD	0.72	5.47	2.26
N	96	90	90
High Test Magnitude			
Mean	2.08	0.70[c]	3.92
SD	0.68	8.33	2.88
N	99	86	86
High Risk			
Mean	2.04	5.01[d]	3.67
SD	0.69	6.11	2.48
N	93	91	91

Response Measure: Mitigation Difficulty; Acceptable Exposure Level.

[a]Calculations were performed on log-transformed data. The value listed for each condition is the inverse of the mean of the logarithm.
[b]Response choices in units of f/l.
[c]Response choices in units of f/cubic ft.
[d]Response choices in units of f/dl.

See Appendix B for the formats being compared, or Table 2 (p. 39), which shows them schematically on the same page.

Test of the locational hypothesis. The Base and Displaced conditions differed only in the placement of the test result on the page. A location high on the page increased perceptions of threat above those elicited by the Base condition (12.95 vs. 11.46, $p < .01$). The effect of displacement on mitigation intentions, however, was not significant, though in the same direction. This is probably attributable to the greater sensitivity of the composite index, rather than to any difference in how perceptions and intentions are affected by location on the risk ladder. As expected, given the equal risks in these two conditions, illness probability ratings were not affected by displacement, nor were maximum acceptable exposure levels.

Test of the test magnitude hypothesis. There were no significant differences between the Base condition and the High Test Magnitude condition. Increasing the numerical size of the test result by a factor of 30 made no difference, suggesting that subjects responded to the risk information they had been given. This somewhat surprising finding is reassuring. Concentration levels for radon in water, for example, are typically higher than for radon in air, although the waterborne risk is usually lower. It is encouraging that homeowners are apparently able to disregard the misleading test magnitude cue, at least when mortality information and smoking comparisons are also provided.

Test of the risk hypothesis. The High Risk condition was rated higher on the perceived threat index than the Base condition (13.24 vs. 11.46, $p < .01$), but these conditions were not significantly different in mitigation intentions or maximum acceptable exposure levels (measured on an equal-interval scale). As might be expected from the 10-fold greater risk that was involved, illness probability estimates were significantly greater in the High Risk condition (5.08 vs. 3.63, $p < .001$).

Comparison of the locational and risk effects. There were no significant differences in perceived threat or mitigation intentions between the Displaced and High-Risk conditions. A 10-fold increase in risk was roughly equivalent to a displacement of half a page.

Illness probability estimates were significantly higher in the High Risk condition (3.89 vs. 5.09, $p < .001$).

Comparison of the test magnitude and risk effects. The High Risk condition was associated with greater perceived threat than the High Test Magnitude condition (13.24 vs. 10.58, $p < .001$), with greater interest in mitigation (3.95 vs. 3.25, $p < .001$) and with greater illness probability estimates (5.08 vs 3.67, $p < .001$).

Accuracy of illness probability estimates. Since a correct answer to the question about illness probabilities was provided in the brochures, the data were analyzed in terms of the size of the discrepancy between subjects' choices and the illness probability indicated by the brochure. For the Base, Displaced, and High Test Magnitude conditions, the asbestos level assigned to subjects was equivalent to a risk of 3 deaths per 1000. The closest choice on the logarithmic response scale was point "4," the point intermediate between 1 in 1,000 (coded as "3") and 1 in 100 (coded as "5"). The assigned level in the High Risk condition was equivalent to a "6" on this scale (3 in 100), intermediate between 1 in 100 (coded as "5") and 1 in 10 (coded as "7").

It is clear from Figure 2 (p. 62) that all the means tended to be low. The High Risk mean was substantially below the correct answer ($p < .0001$), and the Base and High Test Magnitude results were also significantly below the correct answer (p's $< .05$). The difference in errors among conditions was also significant, $F(3,368) = 4.60$, $p < .005$, reflecting the greater underestimation of risk in the High Risk condition. Although risk probability estimates increased as the actual risk increased, in other words, so did the extent of the underestimation. This difference was not due to any difference in the difficulty of finding a risk number near the test result on the brochure format page or finding the same risk number in the illness probability question on the questionnaire; for all conditions, the test result was one of the labeled points on the exposure ladder and the associated mortality risk was given in the next column, while the correct answer on the questionnaire required interpolation.

Acceptable exposure level. As seen in Table 12, the maximum level that subjects found acceptable was considerably less than that to which they were assigned. When expressed in common units of f/l, the between-condition choices were significantly different, $F(3,384) = 6.91$, $p < .0001$, reflecting the fact that the acceptable level in the High Risk condition was greater than in the other conditions ($p < .001$). The remaining conditions did not differ significantly.

Recall, however, that because several different units had been used, the questionnaire response options were not identical across conditions. For example, the High Risk choices were expressed in f/dl instead of f/l. If the data are analyzed in terms of a simple 1-to-12 scale, referring to the 12 choices given but ignoring the labels that accompanied each choice, the means do not vary significantly among the four format conditions, ranging only from 3.62 (Displaced) to 3.92 (High Test Magnitude). These results suggest that in choosing a maximum acceptable level, subjects picked a choice that was a few responses away from the first option, zero, rather than seeking a particular level of risk. It is interesting that the maximum acceptable level in the High Test Magnitude condition, where choices were given in fibers per cubic feet (mean of 3.92, where 4 = 240 f/cu. ft.) was nearly the same as the acceptable level in the Base condition, where the response options reflected identical concentrations, but expressed in fibers per liter (mean of 3.90, where 4 = 8 f/l). This is further evidence that subjects were able to discount the numerical size of their test result in making judgments about the risk.

To summarize Experiment II, variations in mortality statistics and smoking comparisons – that is, variations in actual risk – affected the composite index of perceived threat and mitigation intentions. Illness probability estimates were also affected, but not as much as they should have been to reflect the 10-fold risk difference between the Base and High Risk conditions. The effects of risk variations on maximum acceptable exposure levels were difficult to interpret because of differences among the response scales used in the four conditions.

In contrast to the risk effect, vertical displacement had a significant effect only on perceived threat, the most sensitive of the risk perception measures. The data thus show that subjects were responsive to risk information and somewhat affected by location.

The size of the test numbers had no effect according to any criterion. The data thus provide no support whatsoever for a test magnitude effect. In fact, although the differences were not significant, the High Test Magnitude format showed less risk aversion than the Base format on several measures.

Figures 2, 3, and 4 show the results for the first three response variables in the form of bar graphs, with confidence limits (twice the standard error of the mean) represented by brackets at the tops of the bars. Although the between-format differences in mitigation intentions were smaller and less significant than in the case of the composite threat variable, the pattern of means, visible from Figures 3 and 4, is very similar for the two variables.

Format Effects on Risk Perception Variables: Experiment III

Experiment III explored two new questions: the effects on perceived risk of simultaneously receiving both asbestos and radon risk information, as opposed to receiving the identical information on only one hazard; and the effects on perceived risk of differences in the hazard itself, independent of location, units of exposure magnitude, or risk level. In addition, Experiment III sought to replicate the locational and risk effects observed in Experiment II.

A total of six presentation formats were used. See Appendix C for samples of the six formats, or Table 4 (p. 44), which shows them schematically on the same page. Five planned comparisons were analyzed. Table 13 summarizes the comparisons between conditions.[16,17] Table 14 presents the least-squares adjusted means and standard deviations.

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[16]Only three response measures were used in Experiment III. Perceived mitigation difficulty and maximum acceptable exposure level were dropped from the feedback instrument.

[17]Tests of differences among means were conducted with Bonferroni's technique, controlling for the five post-hoc tests of interest.

Figure 3

Experiment II
Effects of Location, Test Magnitude, and
Risk on Perceived Threat

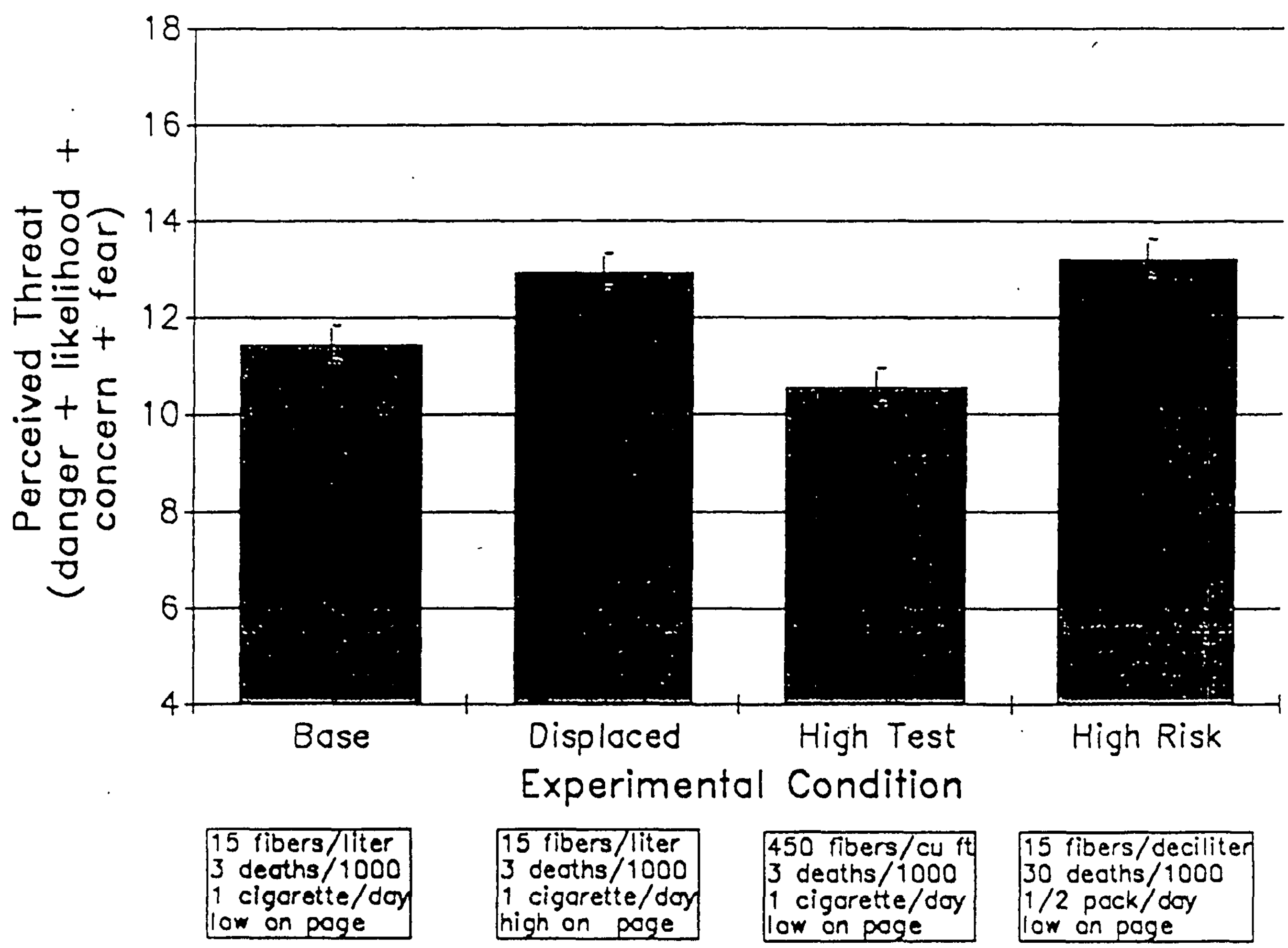


Figure 4

Experiment II
Effects of Location, Test Magnitude, and Risk Magnitude on Mitigation Intentions

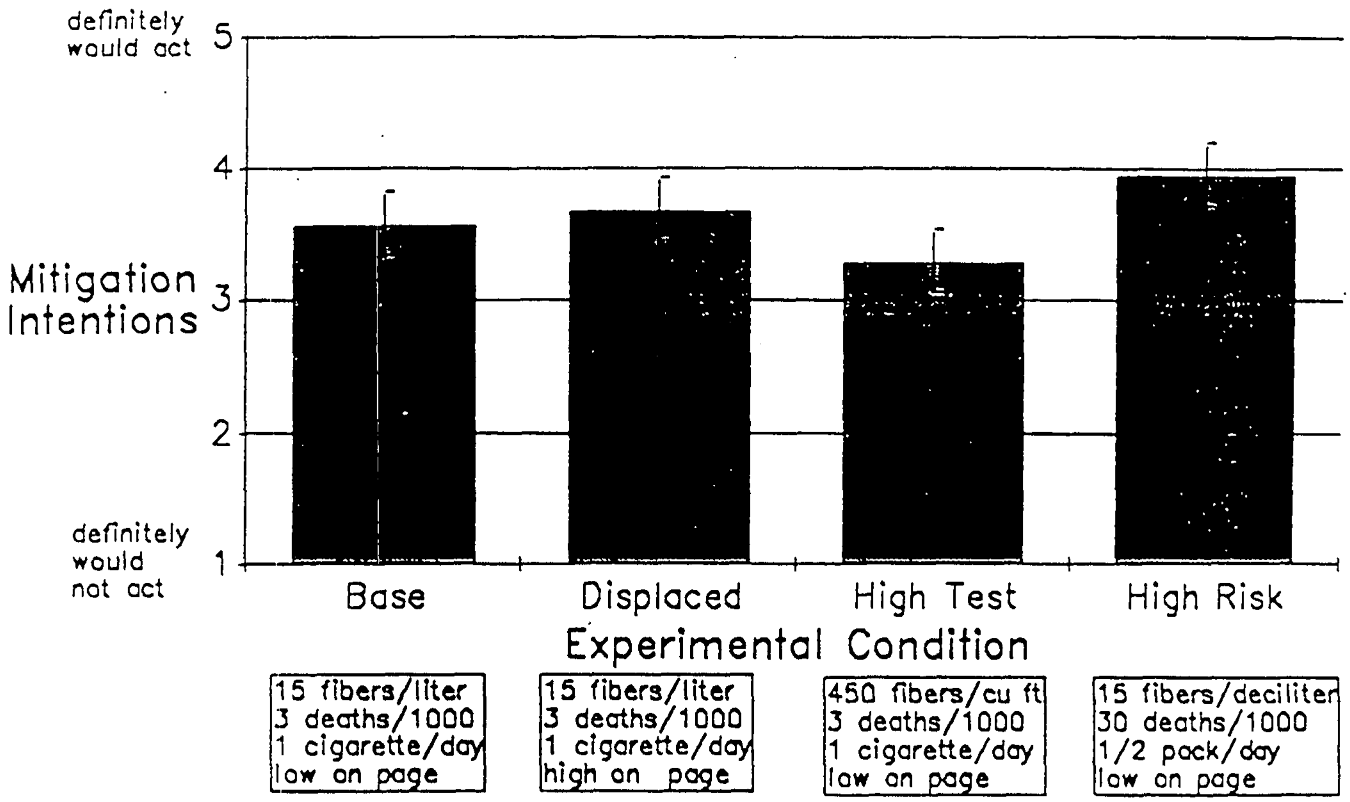


TABLE 13

Experiment III Analysis of Covariance of Format Effects

	Response Measures		
	Perceived Threat Index	Mitigation Intentions	Illness Probability
Comparison	F (df)/ Significance	F (df)/ Significance	F (df)/ Significance
Overall Format Effect	F(5,573)=52.95 ****	F(5,586)=16.79 ****	F(5,521)=32.15 ****
Joint versus Separate Presentations			
Joint Asbestos vs. Base Asbestos	NS	NS	NS
Joint Radon vs. Base Radon	NS	NS	NS
Hazard Effect			
Base Radon vs. High Risk Asbestos	NS	NS	NS
Locational Effect			
Base Asbestos vs. Displaced Asbestos	***	**	NS
Risk Effect			
High Risk Asbestos vs. Displaced Asbestos	***	**	***

Note: The demographic variables that proved significant in Table 6 were used in these analyses as covariates. Comparisons between pairs of conditions were conducted with Bonferroni's technique, controlling for the five post-hoc tests of interest.

NS $p > .05$. * $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

TABLE 14

Experiment III Least-Squares Adjusted Means
and Standard Deviations by Format

	Response Measure		
Format	Perceived Threat	Mitigation Intentions	Illness Probability
Joint Asbestos			
Mean	12.43	3.47	6.39
SD	3.71	1.07	2.43
N	96	95	87
Joint Radon			
Mean	16.83	4.30	10.14
SD	3.71	1.06	2.44
N	93	92	82
Base Asbestos			
Mean	11.58	3.32	6.19
SD	3.71	1.11	2.50
N	96	102	100
Base Radon			
Mean	17.56	4.19	10.15
SD	3.71	1.08	2.40
N	96	96	79
High Risk Asbestos			
Mean	17.97	4.22	10.53
SD	3.72	1.04	2.45
N	105	108	96
Displaced Asbestos			
Mean	14.28	3.79	6.82
SD	3.71	1.08	2.37
N	93	96	90

Figures 5, 6, and 7 compare the Experiment III formats on perceived threat, mitigation intentions, and illness probability estimates.

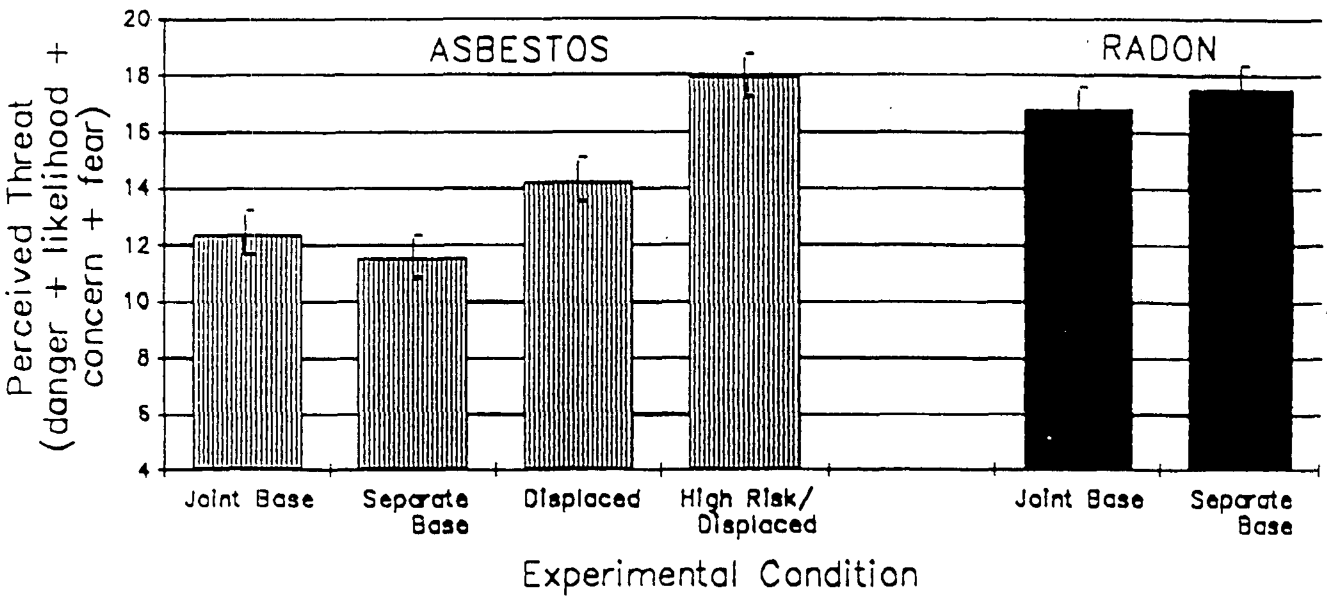
Effects of joint versus separate presentation of hazards. No significant differences were found for either radon or asbestos between the effects of presenting the two hazards together and the effects of presenting them separately. (Recall that risk data on the two hazards were provided, but not recommended action levels.) This was true for all three response measures (the threat perception index, mitigation intentions, and illness probability estimates). The hypothesis that information on one hazard would provide a context or contrast that would influence perceptions of the risk from the other hazard was not supported. (Of course it is possible that a different use of simultaneous presentations might help owners take note of risk differences – for example, presentations that included the different action levels for the two hazards, or presentations that directed readers' attention to the differences more forcefully or interactively.)

Effects of hazard differences. There were no significant differences in subjects' responses to radon and asbestos (holding location and risk constant, and test magnitude nearly constant) on any of the three outcome measures. There may of course be significant hazard differences for other hazards, but responses to radon and asbestos risks were not affected by the identity of the hazard.

Retest of the locational hypothesis. Two of the Experiment III formats utilized the same asbestos exposure level, expressed in the same units, varying only in the position on the page. This retest of the locational hypothesis yielded similar but stronger results than in Experiment II. For the threat perception index, the difference between the mean for the Base Asbestos condition (11.58) and the mean for the Displaced Asbestos condition (14.28) was significant at $p < .001$, compared to a .01 confidence limit in Experiment II. In addition, the effect of location on mitigation intentions, not statistically significant in Experiment II, was large enough to achieve statistical significance in Experiment III (3.32 vs. 3.79, $p < .01$). These effects confirm the previous finding that a half-page vertical displacement does indeed affect risk perceptions.

Figure 5

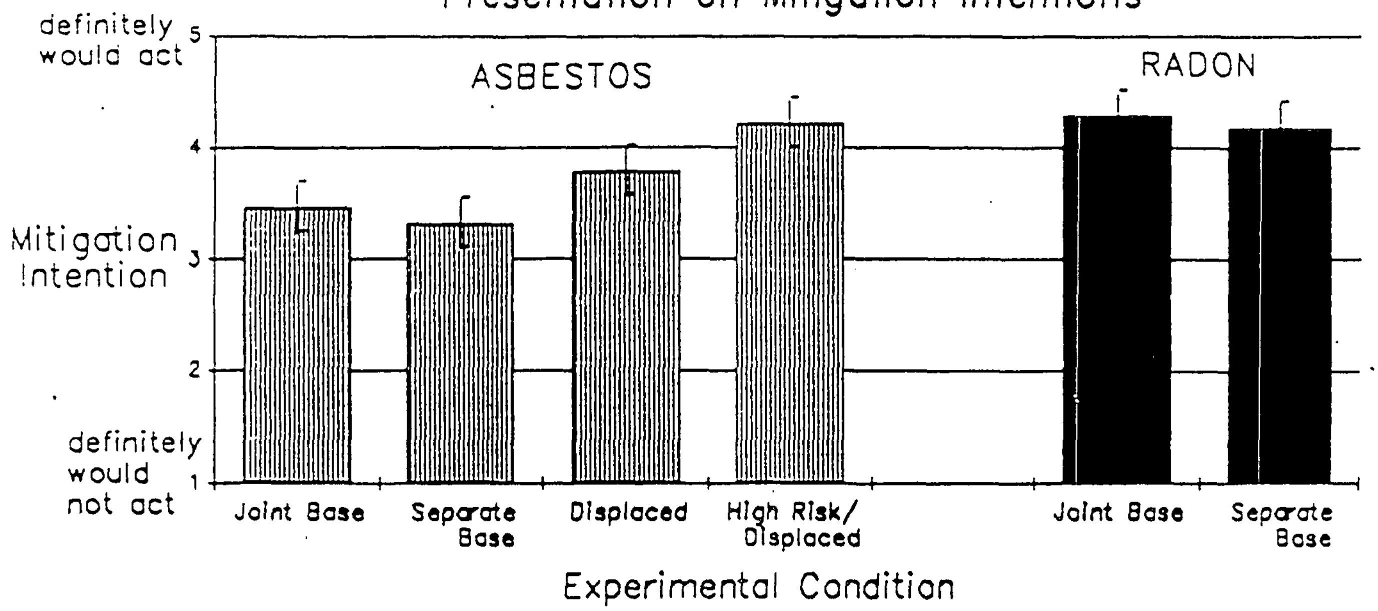
Experiment III
Effects of Location, Risk, and Simultaneous Presentation on Perceived Threat



Joint Base Asbestos: Joint presentation, 25 f/l, 5 deaths/1000, low on page.
Separate Base Asbestos: Separate presentation, 25 f/l, 5 deaths/1000, low on page.
Displaced Asbestos: Separate presentation, 25 f/l, 5 deaths/1000, high on page.
High Risk/Displaced Asbestos: Separate presentation, 60 f/dl, 120 deaths/1000, high on page.
Joint Base Radon: Simultaneous presentation, 25 pCi/l, 125 deaths/1000, high on page.
Separate Base Radon: Separate presentation, 25 pCi/l, 125 deaths/1000, high on page.

Figure 6

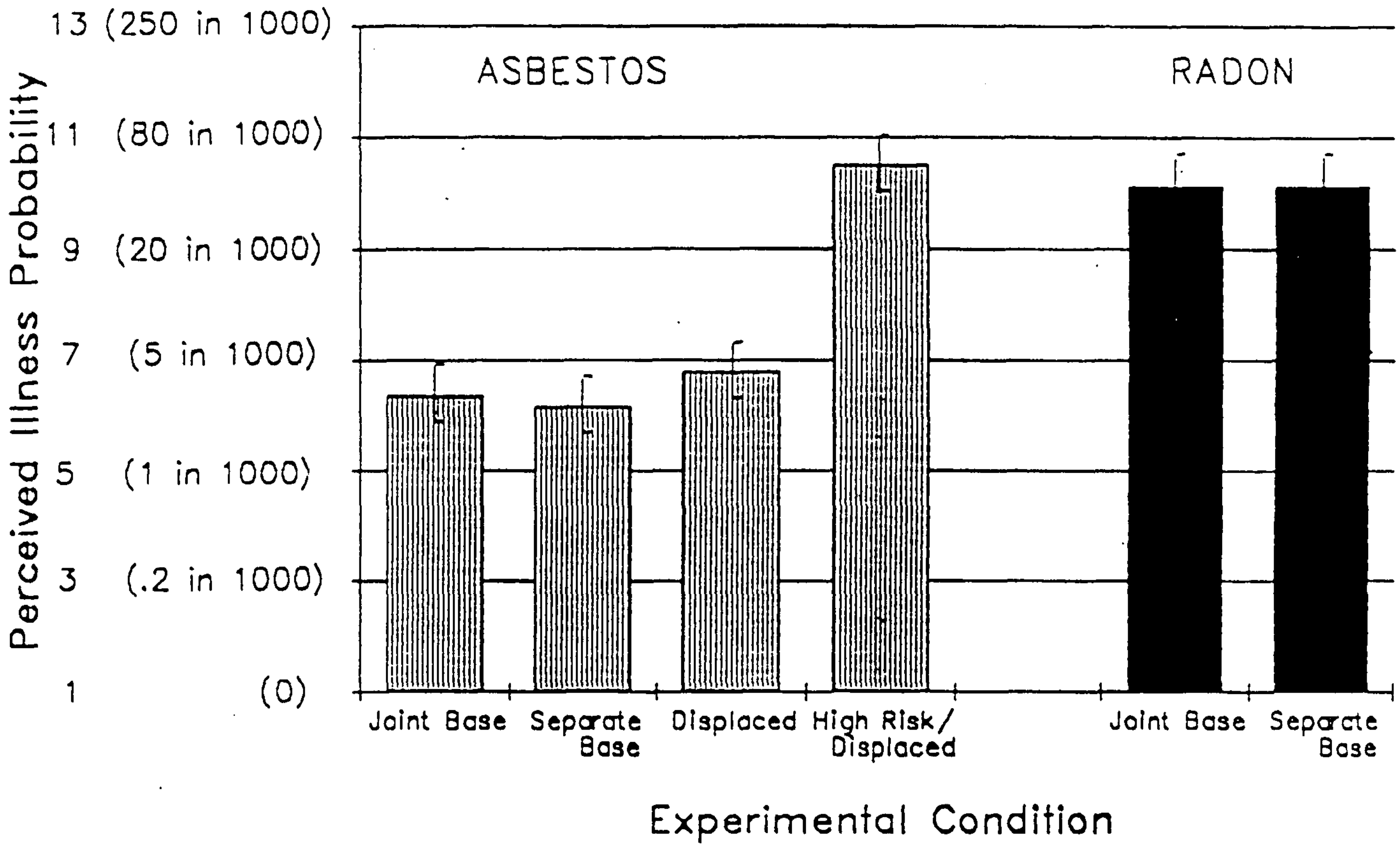
Experiment III
Effects of Location, Risk, and Joint Presentation on Mitigation Intentions



Joint Base Asbestos: Simultaneous presentation, 25 f/l, 5 deaths/1000, low on page.
Separate Base Asbestos: Separate presentation, 25 f/l, 5 deaths/1000, low on page.
Displaced Asbestos: Separate presentation, 25 f/l, 5 deaths/1000, high on page.
High Risk/Displaced Asbestos: Separate presentation, 60 f/dl, 120 deaths/1000, high on page.
Joint Base Radon: Simultaneous presentation, 25 pCi/l, 125 deaths/1000, high on page.
Separate Base Radon: Separate presentation, 25 pCi/l, 125 deaths/1000, high on page.

Figure 7

Experiment III
Effects of Location, Risk, and Joint Presentation on Perceived Illness Probability



Joint Base Asbestos: Simultaneous presentation, 25 f/l, 5 deaths/1000, low on page.
Separate Base Asbestos: Separate presentation, 25 f/l, 5 deaths/1000, low on page.
Displaced Asbestos: Separate presentation, 25 f/l, 5 deaths/1000, high on page.
High Risk/Displaced Asbestos: Separate presentation, 60 f/dl, 120 deaths/1000, high on page.
Joint Base Radon: Simultaneous presentation, 25 pCi/l, 125 deaths/1000, high on page.
Separate Base Radon: Separate presentation, 25 pCi/l, 125 deaths/1000, high on page.

As in Experiment II, no difference was expected between the illness probability estimates of subjects in the Base Asbestos and Displaced Asbestos conditions, and none was found.

Retest of the risk hypothesis. The High Risk Asbestos condition (with the test result high on the page) yielded a significantly higher index of perceived threat than the Displaced Asbestos condition (where the result was also high on the page) (17.97 vs. 14.28, $p < .001$). Similarly, the High Risk Asbestos condition yielded significantly greater intentions to mitigate than the Displaced Asbestos condition (4.22 vs. 3.79, $p < .01$). A similar difference was found for illness probability estimates (10.53 vs. 6.82, $p < .001$). For all three response measures, in short, the risk hypothesis was reconfirmed.

Taken together, Experiments II and III show that risk statistics (deaths per thousand) plus smoking comparisons have an effect on risk perceptions regardless of whether the location on the page is high or low.

Comparison of the locational and risk effects. In contrast to Experiment II, the locational and risk effects could not be directly compared. Focusing on the most reliable variable, the index of threat perceptions, however, one can see from Table 14 that the effect of a half-page displacement was about 2.7 points on the scale, and that a further 24-fold increase in risk added another 3.7 points. This is consistent with the Experiment II conclusion that, in terms of impact on perceived risk, a half-page displacement was roughly equal to a 10-fold change in actual risk.

Accuracy of illness probability estimates. The correct illness probability estimates, treating the choices as a 1-to-13 scale, were "7" for low-risk subjects and "12" for subjects in the High Risk Asbestos and all radon conditions. As suggested by Figure 7, all the means of subjects' ratings were underestimates, and except for the Displaced Asbestos condition, all were significantly less than the correct choice, p's $< .05$.

The errors were significantly different among conditions, $F(5,525) = 5.83$, $p < .0001$. The errors were especially large in the high-risk conditions, with mean errors of 1.46 to 2.11 scale divisions. These results parallel those of Experiment II. Illness probability estimates increased significantly with increases in actual risk, but nearly all estimates were low, and the size of the errors was greatest when the risk was highest.

Effects of perceived hazard characteristics. Experiment III included five measures of hazard attributes whose effects on risk perceptions have been studied (Slovic, Fischhoff, & Lichtenstein, 1985). These measures were included to help shed light on the hypothesized hazard effect. As has already been reported, no such hazard effect emerged. That is, when location on the page, test magnitude, and objective risk were all held constant, subjects did not respond differently to asbestos than to radon on the three risk perception response variables (the composite index of perceived threat, mitigation intentions, and estimates of illness probability).

Nonetheless, subjects did perceive differences between radon and asbestos for three of the five hazard characteristics. (The data used for this comparison come from the Base Radon format and the High Risk Asbestos format. Both of these have the same location on the page, the same test values, and the same risk information. Any differences found are thus attributable to hazard alone.) Table 15 presents these comparisons. No significant differences between radon and asbestos were found for dread, $F(1,206) = 1.93$, NS, or for lethality, $F(1,205) = 2.28$, NS. But significant differences were found between the two hazards in subjects' judgments about the difficulty of mitigation, $F(1,206) = 13.61$, $p < .001$, about unfamiliarity, $F(1,205) = 9.22$, $p < .01$, and about naturalness, $F(1,206) = 110.70$, $p < .0001$. Subjects rated asbestos as being significantly more difficult to mitigate, older (more familiar), and more a man-made hazard than radon.

Additional calculations examined the correlations between the five hazard attributes and the three measures of perceived risk. Table 16 summarizes these analyses.[18] Only dread and lethality were significantly correlated with the response measures, with stronger correlations for lethality. All significant correlations were in the expected direction; that is,

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[18]Correlations were calculated separately for each hazard and then "averaged" using Fisher's r-to-Z transformation.

TABLE 15

Experiment III Radon and Asbestos Ratings on Five Characteristics (Means, Standard Deviations, and Significance Tests)[a]

	Format		Significance	
Hazard Characteristic	Separate Base Radon	High Risk Asbestos	F	Significance Level
Difficulty of Hazard Reduction				
Mean	3.23	4.04	13.61	***
SD	1.46	1.64		
N	99	109		
Dread of Hazard Consequences				
Mean	3.55	3.87	1.93	NS
SD	1.64	1.73		
N	99	109		
Hazard Lethality				
Mean	5.69	5.42	2.28	NS
SD	1.25	1.34		
N	98	109		
Unfamiliarity				
Mean	3.97	3.15	9.22	**
SD	2.05	1.85		
N	98	109		
Natural Hazard (vs. Man-Made)				
Mean	5.85	2.39	110.70	****
SD	1.51	1.33		
N	99	109		

[a]Data from Base Radon scale and High Risk Asbestos scale.

NS $p > .05$. * $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

TABLE 16

Experiment III Correlations of Hazard Ratings with Response Measures[a]

Hazard Characteristic	Response Measure: Perceived Threat Index	Mitigation Intentions	Illness Probability
Difficulty of Hazard Reduction			
Correlation	-0.09	-0.12	-0.02
Significance	NS	NS	NS
N	208	206	179
Dread of Hazard Consequences			
Correlation	0.20	0.20	0.10
Significance	**	**	NS
N	208	206	179
Hazard Lethality			
Correlation	0.45	0.22	0.31
Significance	****	**	***
N	207	205	179
Unfamiliarity			
Correlation	0.01	0.02	-0.02
Significance	NS	NS	NS
N	207	205	178
Natural Hazard (vs. Man-Made)			
Correlation	0.08	0.06	0.01
Significance	NS	NS	NS
N	208	206	179

[a]Data from Base Radon scale and High Risk Asbestos scale.

NS $p > .05$. * $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

higher ratings on dread and lethality were associated with higher ratings on the perceived risk variables. These results replicate Slovic et al.'s (1985) finding that the dimension they label dread (which includes ratings of both dread and lethality) influences risk perceptions, but the dimension they label unfamiliarity does not. Variations in perceptions of lethality affected illness probability estimates even though the information brochure provided explicit data about illness probabilities.

The within-hazard and between-hazard results are entirely consistent. The three hazard attributes that distinguished radon from asbestos were not correlated with risk perceptions within a hazard condition; this is consistent with the absence of differences in perceived riskiness between radon and asbestos. The two hazard attributes that were correlated with risk perceptions within a hazard condition – dread and lethality – did not lead to between-hazard differences in perceived risk because radon and asbestos were rated the same on these two dimensions. Thus, although radon and asbestos are perceived differently with respect to some hazard characteristics, these are not the characteristics that are tied to perceived riskiness.

In summary, Experiment III found no evidence of any impact on risk perceptions of joint versus separate presentations of radon and asbestos.[19] Nor was there any evidence of a hazard effect for these two substances. That is, when risk and location on the page were held constant, subjects' risk perceptions for radon were not significantly different from their risk perceptions for asbestos.[20]

As in Experiment II, a substantial risk effect was found. Subjects responded to

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[19]This finding might be very different if other hazards were being compared. Radon and asbestos are similar on many key dimensions, yielding no hazard effect in this experiment. Perhaps with hazards that were more dissimilar – radon and nuclear waste, for example – a joint presentation might yield risk perceptions that were different from those generated by separate presentations.

[20]Of course a different finding might well result from the choice of hazards that differ from each other more on those hazard characteristics that significantly affect risk perception.

higher levels of asbestos with higher risk perceptions, even when location on the page was held constant.

Again replicating the Experiment II findings, a significant locational effect also emerged for the composite risk index and for mitigation intentions. When actual risk was held constant, subjects responded to location on the page with significant alterations in risk perception. The locational effect from a half-page displacement was about three-quarters of the effect of a 24-fold difference in risk.

CHAPTER FOUR

DISCUSSION

The overarching question examined by this research is the extent to which different ways of presenting risk data – in this case, data about asbestos or radon – can help individuals perceive their risk accurately and respond appropriately.

Dependent Variables

Five dependent variables were used. The most sensitive of these was the composite index of threat perception, comprising four items that were strongly intercorrelated: perceived likelihood of harmful effects, perceived seriousness, concern, and fear. The composite index consistently showed the strongest relationships with experimental manipulations; in no case did any manipulation achieve a higher level of significance for one of the other dependent variables than for the composite index. This is not surprising. Not only did the index have the reliability provided by four intercorrelated items; they were also the items (perceived likelihood, perceived seriousness, emotional arousal) most likely to be affected by variations in risk explanation.

A single question about mitigation intentions was treated as a second dependent variable, in order to have a behavioral measure. It was expected that relationships with this item would be weaker than with the composite threat perception index, not just because it was a single item but for two other reasons as well. First, behavioral measures are typically more resistant to influence than measures of attitudes or emotions. Second, this particular behavioral measure was doubly contingent, twice-removed from subjects' real world: It asked subjects to judge their own anticipated behavior (as opposed to measuring behavior itself), and it did so under hypothetical assumptions.

The third dependent variable was subjects' estimates of illness probability. Except in the first experiment, the experimental manipulations provided explicit data on illness probability; this item was therefore conceptualized more as a comprehension check than as a measure of risk perception. Estimates of illness probability should have been affected by actual risk (since the illness probability information provided in the experimental manipulations varied with the risk), but there was little reason to expect a significant effect from the other treatments.

The last two dependent variables were judgments of mitigation difficulty and choices of the highest asbestos or radon level subjects would find acceptable (that is, the highest level at which they would choose not to mitigate). None of the experimental manipulations addressed these two issues directly, and no impact was therefore predicted. They were included in Experiments I and II to find out whether any of the experimental manipulations would influence them indirectly, but were dropped from Experiment III to make room for items on hazard differences.

The findings are discussed below in terms of the first two dependent variables, the composite index of threat perception and mitigation intentions. The other three dependent variables are discussed only when a significant relationship was found.

Findings

Six different factors were examined (in one or more of three experiments) to determine their impact on subjects' risk perception: actual risk, the presence of a risk ladder, location on the risk ladder, units of exposure magnitude, differences between two hazards, and simultaneous presentation of two hazards. Care was taken to make sure each factor was varied separately, with the others tightly controlled.

Effects were found for the first three factors, but not for the second three. The results will be discussed in the order in which the factors are listed. Three additional findings are mentioned briefly at the end of the section.

1. The risk magnitude effect. Both Experiment II and Experiment III included a test of the impact of actual risk on subjects' risk perceptions (risk was explained in terms of excess cancer deaths and comparisons to smoking). In Experiment II, a 10-fold increase in risk significantly increased the composite index of perceived threat. The effect on mitigation intentions was in the same direction, but did not meet the .05 significance criterion. In Experiment III, a 24-fold increase in risk significantly increased both the composite index and mitigation intentions. As predicted, estimates of illness probability were also increased by actual risk in both experiments.

The finding that risk affects risk perception is not surprising. On the contrary, it would be shocking if risk variations of an order of magnitude or more were invisible to subjects instructed to make judgments about the extent of their risk. This is especially the case in the relatively serious range of hypothetical risks to which subjects were assigned (3 and 30 deaths per thousand in Experiment II, 5 and 120 deaths per thousand in Experiment III). Comparable differences in deaths per billion might well have had negligible effects.

The finding of a significant risk effect should not be interpreted as meaning that subjects had a thorough understanding of the risk data presented to them – much less that they would act on that understanding. The only dependent variable with a "right answer" was illness probability estimates. Subjects in all conditions tended to underestimate their risk, and those in the high risk conditions underestimated it the most. That is, illness probability estimates did increase as actual risk (that is, actual illness probability) increased, but the gap of unrealistic optimism also increased with increasing risk.

2. The effect of a risk ladder. Experiment I tested the hypothesis that subjects would perceive their risk to be greater when presented simply with a suggested "action level" at which mitigation is recommended than when presented with such a standard located midway up a risk ladder. Even though the ladder did not include risk data, the

context it provided – the information that levels higher than one's own are not rare – was expected to reassure subjects and thus reduce their perception of risk.

The hypothesis was confirmed, albeit weakly, for the composite index of perceived threat, but not for mitigation intentions.

The finding that a risk ladder somewhat reduces risk aversion helps explain the Phase One finding that subjects were most risk-averse when presented simply with a standard (as opposed to other treatments that provided risk data, risk comparisons, advice, etc.). Apparently, people presented simply with two pieces of information, the recommended action standard and their own reading, are likely to interpret this information in alarming ways. If their reading is above the standard, they have no way of knowing "how far" above the standard it is or "how far" above the standard people's readings typically range; even if their reading is below the standard, they seem to derive little reassurance from that fact in the absence of some information on the range of possible readings.

The mere addition of a risk ladder tells them nothing about death rates at the different levels, or even about the frequency with which these levels are encountered. But the range of levels included on the ladder at least suggests the range of levels that experts must expect people to encounter. This contextual information appears to reassure subjects whether their assigned readings are above or below the action standard. It seems likely that subjects assigned a level at or near the top of the ladder would be alarmed rather than reassured by the ladder. This was not tested. All subjects in Experiment I learned from the ladder that things could be worse, and they tended to find this additional context reassuring.

The Phase One research found a sharp "step increase" in perceived threat above the standard for subjects receiving the standard-only condition. (Subjects tended toward risk aversion in this treatment regardless of their assigned level, but those assigned a level above the standard were even more risk-averse.) This led to the hypothesis that the reassuring effect of the risk ladder should be greatest for subjects with levels above the standard (but not right at the top of the ladder). As expected, the effect of the manipulation on the composite index of perceived threat was stronger for levels above the standard. But the difference was not sufficient to yield a significant format x level interaction, and even for levels above the standard there was no significant effect of the risk ladder on mitigation intentions.

The size of the risk ladder effect cannot be compared directly with the size of the risk effect, since they were studied in different experiments. But indirect comparison is possible. Averaged across all readings, the addition of a risk ladder decreased the composite threat perception index by 0.86 units on a 19-unit scale (4.5% of the total scale range); above the standard, the decrease averaged 1.23 units (6.5%). In Experiment II, the effect of a 10-fold difference in risk was 1.78 units (9.4%); in Experiment III, a 24-fold difference in risk yielded an average difference in perceived threat of 3.69 units (19.4%). Even above the standard, then, the presence or absence of a risk ladder had less effect on perceived risk than one order of magnitude in actual risk.

Still, the effect was large enough to be of practical value. If the communicator's goal is maximum risk aversion – that is, if the hazard is serious and the audience is inclined toward apathy – a standard without additional information is ideal; its very ambiguity generates the desired risk-averse response. If panic is a problem and the goal is to provide reassuring context, on the other hand, a risk ladder is worth adding. Note that no additional information is required to add a ladder. Even when data are unavailable on deaths per thousand or on the distribution of readings, a risk ladder can always be added to an action standard when a less risk-averse response is desired.

3. <u>The effect of location on the risk ladder</u>. The locational hypothesis was introduced at the end of Phase One to account for that study's finding that many formats were able to help subjects distinguish the effects of high versus low levels of asbestos or radon, but no format successfully helped subjects distinguish the effects of asbestos from the effects of radon. The risk associated with a particular level of asbestos or radon, it was noted, was proportional to that level's location on the risk ladder (higher risks were higher on the ladder), while the difference in risk between asbestos and radon was not reflected in their

respective ladders. If subjects were responding to location on the ladder rather than to risk information, therefore, their risk perceptions would be sensitive to within-hazard differences but not to between-hazard differences – exactly what the Phase One data had shown.

The locational hypothesis was tested in Experiments II and III. By displacing the risk ladder, the same hypothetical reading with the same risk information was located either one-quarter of the way up the ladder or three-quarters of the way up the ladder. Both experiments found a significant locational effect on the composite index of perceived threat. In Experiment II, a displacement of half a page led to a 1.49-unit effect on the 19-unit threat perception index (7.8% of the total scale range), while a 10-fold difference in actual risk produced an effect of 1.78 units (9.4%). (This small difference between the two effects was not statistically significant.) In Experiment III, a displacement of half a page yielded a difference of 2.70 units (14.2%) in the composite index of perceived risk, while a 24-fold risk difference added another 3.69 units (19.4%). The findings with respect to mitigation intentions were less compelling. In Experiment III, the effect on mitigation intentions was statistically significant, but in Experiment II it was too small to achieve statistical significance. This failure to find a mitigation effect in Experiment II is probably a result of the insensitivity of the single-item measure of mitigation intentions, not an indication that location on the risk ladder affects perceptions more than intended behavior.

The effect of location on risk perception is a sizable effect and an important finding. (It is not really a surprising finding, however. Virtually every primer on graphical presentation of data stresses that graphs can be truncated, extended, or displaced in order to exaggerate or minimize the effect displayed. See for example Huff, 1954.) Risk information developed to guide laypeople is often arrayed on a risk ladder, and the structure of the ladder is frequently determined more or less arbitrarily. How low should the ladder begin? How high should it rise? Should the scale be linear or logarithmic? The answers to these questions are not obvious. They depend not just on the seriousness of the risk and the anticipated apathy or panic of the audience, but also on the actual range of levels that are typically encountered and on the ethical values of those constructing the ladder. What is clear from the data is that people's risk perceptions can be meaningfully altered – whether intentionally or arbitrarily – by constructing the ladder so that their risk appears low or high on the page.

4. The effect of test magnitude. In the Phase One research, radon exposures were expressed in picoCuries per liter, while asbestos exposures were in fibers per liter. The risk associated with a level of radon with the same numerical exposure magnitude was substantially higher than the risk associated with that level of asbestos; that is, X pCi/l of radon constitutes a greater risk than X f/l of asbestos. This suggested another possible explanation for the Phase One finding about within-hazard versus between-hazard differences. Perhaps subjects responded appropriately to differences in level within a hazard because the exposure numbers themselves varied with the risk, while failing to respond to between-hazard risk differences because the numbers were not substantially different.

This hypothesis was tested in Experiment II. By expressing asbestos risk alternatively in fibers per liter and in fibers per cubic foot, a 30-fold difference in test magnitude was achieved without any difference in risk.

No significant effects were found. In fact, the composite index of perceived threat and the measure of mitigation intentions were actually somewhat lower – though not significantly so – in the High Test Magnitude condition than in the Base condition. The evidence is convincing that the numerical magnitude of test numbers does not influence perceived risk.[21]

This somewhat surprising finding is reassuring. Concentration levels for radon in water, for example, are typically higher than for radon in air, although the waterborne risk is usually lower. It is encouraging that homeowners are apparently able to disregard the

[21]This finding may not be applicable in cases where the actual risk is lower and the numbers used are higher and less familiar. Some risk communication practitioners claim that audiences can be more concerned about one part per billion than one part per million, mistakenly interpreting the larger denominator as a larger risk. No research has compared the risk perception effects of, say, risk probabilities of one-in-a-million versus one-in-a-billion versus one-thousand-in-a-billion.

misleading test magnitude cue, at least when mortality information and smoking comparisons are also provided. A study to determine whether subjects can appropriately rank the risks from air and water radon readings would be a useful follow-up.

5. The effect of hazard differences. A third possible explanation was also considered for the Phase One finding that subjects were more sensitive to within-hazard risk differences than to between-hazard risk differences. Perhaps there were particular characteristics of the two hazards, asbestos and radon, that made the former more alarming to subjects than the latter, thus tending to cancel out the effects of the fact that the latter was the greater risk (at the levels specified). It is not speculation, but established fact, that some hazards tend to generate more public concern, risk aversion, and perceived high risk than other risks; a substantial psychometric research literature has explored both the differences in risk perception among particular hazards and the hazard characteristics that account for those differences (see for example Slovic, Fischhoff, and Lichtenstein, 1985).

Experiment III tested for risk perception differences between radon and asbestos. In anticipation of finding some differences, Experiment III also added measures of five hazard characteristics: difficulty of reducing the risk, dread, lethality, unfamiliarity, and the natural/man-made distinction.

Surprisingly, no differences were found between radon and asbestos in the composite threat perception index or in mitigation intentions, when risk level and location on the page were held constant. Of the five hazard characteristics measured, three – difficulty of reducing the risk, unfamiliarity, and natural/man-made – showed significant differences between radon and asbestos; radon was seen as easier to mitigate, less familiar, and less man-made than asbestos. None of these three hazard characteristics was significantly correlated with the dependent variables. By contrast, the two characteristics – dread and lethality – that were significantly correlated with perceived risk did not significantly distinguish radon from asbestos.

These results are internally consistent, and consistent with the findings in Slovic, Fischhoff, and Lichtenstein, 1985. Radon and asbestos, apparently, do not differ substantially in those hazard characteristics that affect risk perception. For two other hazards that did differ substantially in the hazard characteristics that affect risk perception, a significant hazard effect on risk perception would be expected. Radon and nuclear waste, for example, probably differ in the amount of dread they trigger; dread, in turn, significantly affects risk perception, both in the present study and in the literature. Holding actual risk, location on the page, and other factors constant, one would expect to find a difference in perceived risk between radon and nuclear waste facilities.

6. The effect of simultaneous presentation. The final factor tested in the Phase Two research was the possibility that the simultaneous presentation of asbestos and radon risks on two parallel ladders – in effect, on the same ladder – might help subjects understand that the asbestos risk was much less serious than the radon risk. This was tested in Experiment III, and the hypothesis was rejected. There were no significant differences between the joint and separate presentations for either radon or asbestos. Of course it is possible that a different use of simultaneous presentations might help owners take note of risk differences – for example, presentations that included the different action levels for the two hazards, or presentations that directed readers' attention to the differences more forcefully or interactively.

As the previous section detailed, subjects' risk perceptions of radon and asbestos were not significantly different. Perhaps for two hazards that did vary in perceived risk – radon and nuclear waste, for example – simultaneous presentation might have an impact (as opposed to separate presentations). This remains to be tested.

It should be noted that the simultaneous presentation hypothesis was very narrowly framed in the present study. That is, location on the risk ladder was held constant; whether the two hazards were presented simultaneously or separately, the asbestos risk was always one-quarter of the way up the ladder, and the radon risk was always three-quarters of the way up the ladder. In many practical applications, by contrast, presenting two hazards simultaneously would mean extending the risk ladder upwards and downwards to encompass the range of risks entailed by the two different hazards. Since the normal range of asbestos hazards is lower in risk than the normal range of radon hazards, a joint presentation as opposed to separate presentations would tend to move asbestos readings further down on the page and radon readings further up. The locational effect would thus yield decreased asbestos risk perceptions and increased radon risk perceptions – even if there were no added effect of simultaneity.

To put this another way, the findings that have been discussed so far strongly support the locational explanation for the Phase One result that subjects are much better able to distinguish within-hazard risk differences than between-hazard risk differences, at least insofar as asbestos and radon are concerned. Phase One subjects had trouble recognizing that radon was a more serious risk than asbestos, the Phase Two results strongly suggest, not because they were misled by differences between the two hazards or by similarities in the numerical values of the test numbers, but because radon and asbestos were each presented on a separate risk ladder that encompassed a limited range of risks. On a "composite" risk ladder that ran from the lowest level of the asbestos ladder to the highest level of the radon ladder, the findings suggest, asbestos risk perceptions would be diminished and radon risk perceptions would be augmented.

It may be productive to envision a "composite" risk ladder embracing a still wider range of hazards – one that can cover very low probability risks (pedestrian is hit by lightning) at the bottom of the ladder and very high probability risks (smoker gets lung cancer) at the top. If such a ladder can be devised in a way that is comprehensible to laypeople (it would have to be logarithmic, certainly), it should excel at helping people perceive between-hazard differences. But within-hazard differences are typically much smaller; they would be compressed into a small portion of this expanded ladder. Inevitably, therefore, the composite ladder would be much less successful than narrower single-hazard ladders at pointing to within-hazard differences.

7. Three other findings. Three other findings of interest concern demographics, estimates of illness probability, and maximum acceptable levels.

- Older subjects tended to be less risk-averse than younger subjects; less educated subjects tended to be less risk-averse than more educated subjects; men tended to be less risk-averse than women. However, none of the associations between a demographic variable and a risk perception variable was significant for all three experiments.
- As mentioned earlier, subjects were consistently low in their estimates of illness probability, even though the information called for in the questionnaires was provided in the brochures. Although risk probability estimates increased as the actual risk increased, so did the extent of the underestimation.
- Subjects' judgments of the highest exposure level they would consider acceptable varied depending on the options provided; when responses were converted into a simple 1-12 scale independent of the options provided, no significant differences were found. This suggests that subjects did not choose a particular level of risk in response to the question, but rather selected a choice that was a few responses away from the first option, zero. In essence, they chose a location, not a risk. The highest acceptable levels were usually significantly lower than the action guideline provided.

Format Findings, Risk Communication Criteria, and Ethics

To determine how to use findings such as those discussed here, it is necessary first to establish criteria for successful risk communication. As was noted at the start of this report, the entire focus of this research has been on ways of explaining risk magnitudes more effectively – that is, ways to help people understand the size of their risk. The research whose second phase is reported here represents the most sustained effort to date to find out how far cognitive explanation can bring us: how much risk response can be shaped by effectively presented data alone.

The dependent variable that proved most sensitive throughout the study, the composite index of perceived threat, was an amalgam of cognitive factors (perceived seriousness, perceived likelihood) and affective ones (concern, fear) – but the manipulations tested were exclusively cognitive. A more controversial class of risk communication strategies involves efforts to influence risk responses through appeals to emotion or direct manipulations of behavior: dramatic fear appeals, social pressure, rewards for compliance, etc. Considerable research demonstrates that these non-cognitive approaches can be very effective -- but they raise serious ethical dilemmas for many risk communicators.

Some would object on ethical grounds even to the manipulations studied here. Of the three factors that proved to have impacts in this study -- risk itself, the presence of a risk ladder, and location on the ladder -- only the first is unexceptionable. To include or exclude a risk ladder in order to diminish or exacerbate people's concerns, or to extend or truncate or displace the ladder for the same reason, is in the judgment of some observers to leave the domain of risk education and enter that of risk propaganda. Of course one must either include or exclude a ladder, and if there is a ladder the end points must be set somehow. But some would prefer to make these decisions without considering the (now readily predictable) impact of such decisions on the risk judgments of the audience.

For those who do not find these ethical issues troublesome, practical problems remain. To determine whether one wishes to dampen or augment an audience's level of risk perception, one must have some expectations about what level of risk perception is likely to be encountered, and some beliefs about what level is appropriate. Some hazards are underestimated or overestimated by nearly everyone, so the task is to alert or to reassure across-the-board. The absence of a risk ladder appears to alert across-the-board; its presence appears to reassure. For other risks, however, the task may be to alert those who are particularly inclined toward apathy and to reassure those who are particularly inclined toward panic. Nothing in the Phase Two research suggests an approach that discriminates among audiences in this way.

Most commonly, risk communicators seek a strategy that will tend to alert those who are being exposed to relatively high levels of the hazard in question, while reassuring those whose exposure is relatively low. Certainly for a hazard like radon or asbestos, the ideal communication approach would generate increased perceptions of threat and increased intentions to mitigate among those whose readings were high and decreased perceived threat and intentions to mitigate among those whose reading were low. The Phase One research found that an action guideline could accomplish this goal. The Phase Two research suggests that another promising approach is to truncate the risk ladder at both ends. A radon ladder that runs from 2 to 40 pCi/l, for example, should be simultaneously more calming to a homeowner with a 2.5 pCi/l reading and more alarming to a homeowner with 35 pCi/l than one that runs from 0.2 to 400.

But to focus on one hazard at a time misses the key finding of the Phase One research. Several communication formats do a fairly decent job of helping people distinguish 2.5 pCi/l of radon from 35 pCi/l of radon (though some formats do better than others). The more intractable problem is to help people distinguish 2.5 pCi/l of radon from the much less serious risk of 2.5 f/l of asbestos. The locational effect can be harnessed to this task as well. By extending the risk ladder in both directions, so that it runs down to the lower levels of asbestos risks and up to the higher levels of radon risks, the communicator can assure that all but the highest asbestos risks will be near the bottom of the ladder (and therefore a source of calm), while all but the lowest radon risks will be near the top (and therefore a source of alarm).

The problem here is obvious. The strategy that helps people see the difference between radon and asbestos obscures the difference between high and low levels of one hazard. The strategy that helps people see the difference between high and low levels obscures the difference between radon and asbestos. There may of course be a strategy that accomplishes both, but it has yet to be found. To select among the strategies that have been found, one must know what one wants to accomplish, and must accept that other goals may be disadvantaged in the process.

Next Steps

What have we learned from the first two phases that guides us in trying to explain risk magnitudes? We have learned that the task is not impossible. When risk magnitude data are presented, higher risks do generate higher perceived threat and mitigation intentions than lower risks. We have also identified four factors other than risk magnitude data that significantly affect risk perception: action standards and explicit advice (from Phase One), the presence of a risk ladder and location on the ladder (from Phase Two). Finally, we have learned that all of these effects are relatively small; studying them reliably requires sizable samples of study participants and sensitive response measures.

Several questions remain unanswered. The role of risk comparisons was explored in the first budget period; the results suggested that comparisons to smoking risk had only modest benefits. Considerable anecdotal evidence about the utility of risk comparisons suggests that this question should be investigated further, this time perhaps without the presence of a risk ladder and certainly without the presence of a standard.

Another variable not explored in this research so far is the use of graphic representations of probability or concentration data. The first EPA Citizen's Guide to Radon made considerable -- and controversial -- use of matrix of faces and crosses to show mortality probabilities. A more recent EPA report, Hazardous Substances in Our Environment: A Citizen's Guide to Understanding Health Risks and Reducing Exposure (EPA 230/0990081), used a similar matrix. One published study (Kaplan, Hammel, and Schimmel, 1985) suggests that this graphic approach may help to lower anxiety about low-probability risks. It is not at all clear what the effects of such graphical approaches are with larger probabilities.

In addition to exploring these issues, it would be useful to determine the effectiveness of a "maximum impact" treatment that takes advantage of what has been learned so far about standards, advice, risk ladders, etc.

Considerable emphasis has been put in this discussion section on the likelihood that very different strategies may be required for helping people see that a small risk is small than for helping people see that a large risk is large. (Advice, for example, appears to be much better at the former than the latter.) Moreover, the policy implications of these two types of risk communication are very different. In the past several years, for example, the

Environmental Protection Agency has devoted considerable effort to exploring the discrepancies between expert and public assessments of risk and to developing policies that take cognizance of these different assessments. The need to become more skilled at explaining serious risks is grounded in public health and similar concerns; lives are at stake when an agency tries to warn people about serious risks. When people persist in worrying disproportionately about minuscule risks, on the other hand, the costs range from unnecessary anxiety to misused environmental protection dollars, from public policy gridlock to reduced agency credibility.

The Phase One and Phase Two research focused on two hazards, radon and asbestos. At the levels used in the research, both pose relatively serious risks. Radon and asbestos are not identical hazards, of course. But on the variables that best predict whether a hazard will provoke underreaction or overreaction from the public – dread, control, trust, fairness, etc. – they are similar. (As noted earlier, significant risk perception differences between the two hazards were not found.) In the language of "hazard versus outrage" (Sandman, Klotz, and Weinstein, 1987), the research so far has focused on risks that were moderate to high in hazard and low in outrage. Future research should look explicitly at a high-hazard, low-outrage risk to which the public typically underresponds and a low-hazard, high-outrage risk to which the public typically overresponds – for example, radon and low-level radioactive waste facilities.

Finally, it must not be forgotten that all the research so far has made use of hypothetical "assigned" exposure levels. The efficiency and ethical preferability of this method are clear. But the time is approaching when the findings from this research must be confirmed with citizens' actual exposure levels.

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APPENDIX A

EXPERIMENT I BROCHURES, FORMATS, AND QUESTIONNAIRES

Experiment I had two conditions, standard-only and standard+ladder, for asbestos only. The Appendix includes the full three-page standard-only brochure with the format on the third page, followed by the last two pages of the four-page standard+ladder brochure with the format on the fourth page (the first two pages were identical). The cover letter and questionnaire are at the end of the Appendix.

Test Brochure*

4/88

BASIC ASBESTOS INFORMATION

WHAT IS ASBESTOS?

Asbestos is a mineral fiber found in rocks. There are several kinds of asbestos fibers, all of which are fire-resistant and not easily destroyed by natural processes. Because of its desirable qualities, asbestos has been used in a wide variety of products including appliances, ceilings, wall and pipe coverings, floor tiles, and some roofing materials.

WHY THE CONCERN ABOUT ASBESTOS?

Although asbestos has many benefits for humans, it is also a very dangerous mineral. Breathing airborne asbestos fibers has been shown to cause: (1) Asbestosis - a serious lung disease which can lead to disability and death; (2) Lung cancer - a disease that is incurable and almost always fatal; and (3) Mesothelioma - cancer of the lining of the lungs or abdominal cavities. The greater the exposure to asbestos, the more likely it is that one of these serious diseases will develop. Workers who handle or come into contact with asbestos on a daily basis are open to the greatest health risks.

There is no level of exposure to asbestos fibers that is completely safe. The greater the concentration of asbestos, the greater the risk.

HOW DOES ASBESTOS AFFECT US?

The danger arises when asbestos fibers are released from the product or material. These fibers are so small that they cannot be seen. They can float in the air for a long time and can pass through the filters of normal vacuum cleaners and get back into the air. Once inhaled, asbestos fibers can become lodged in tissue for a long time. After many years cancer or asbestosis can develop.

Cigarette smoking and asbestos together are especially hazardous. Exposure to asbestos plus smoking gives an even greater risk of lung cancer than adding the risk from smoking alone to the risk from exposure to asbestos alone.

Asbestos found in "friable" materials is most dangerous. Friable materials are materials that can be crumbled, pulverized, or reduced to powder by hand pressure. Asbestos insulation sprayed on a ceiling is an example of a friable material. In contrast, vinyl

* Because this is an experimental brochure, please check with other authorities before taking any action in your home.

asbestos floor tile is not usually friable. The asbestos fibers are firmly bound or sealed into the tile and can be released into the air only if the tile is cut, ground, or sanded.

WHERE IS ASBESTOS LIKELY TO BE FOUND IN THE HOME?

There are several areas in the home where asbestos problems are most likely to arise. These include:

* Wall construction material and pipe insulation, especially those dating between 1920 and 1972. (This includes materials found in and behind plaster or wallboard and in paper tape.)
* Friable ceilings in buildings built or remodeled between 1945 and 1978.
* Material found in stoves and furnaces such as insulation and millboard and door gaskets.

Other asbestos-containing products that you may find in the home include:

* Patching compounds and textured paints. (Since the use of asbestos was banned in 1975, you are most likely to find it when sanding or scraping old or damaged material in older houses.)
* Vinyl floor tiles and flooring.
* Roofing, shingles, and siding.
* Appliances with asbestos-containing parts or components, such as toasters, broilers, slow cookers, dishwashers, refrigerators, ovens, ranges, clothes dryers, electric blankets, and popcorn poppers. (Unless broken or misused, most appliances with asbestos are safe. There has been a general decline in the use of asbestos in these appliances during recent years. If asbestos is still used, it is in parts which will probably not release fibers during use.)

Having significant amounts of asbestos in the home is not rare. Many old homes in New Jersey could create health problems for residents because of materials that may release asbestos fibers into the air.

HOW CAN I TELL IF I HAVE ASBESTOS IN MY HOME?

The manufacturer of a product may be able to tell you, based on the model number and age of the product, whether or not it contains asbestos. People who have frequently worked with asbestos (such as plumbers, or building or heating contractors) can often tell you whether or not material contains asbestos by looking at it.

Problems may occur in the home where asbestos-containing materials are worn, damaged, or exposed to the air. If you have wall, you should have the material analyzed to determine if it contains asbestos. Laboratory analyses range from about $20 to $40 per sample. Several samples may be required to gain an accurate determination of asbestos content.

If you suspect that you have a problem, you may also want to have an air sample taken to measure the amount of asbestos fibers circulating inside your home. To collect the sample, a laboratory will send a technician to your home. A pump is used to draw air from the room into a filter that will trap the asbestos. An electron microscope is used to count the number of fibers trapped in the filter. It takes about six hours to collect the sample and costs between $100 and $400, depending on the laboratory and technique used. The results of the test can be reported in units of "fibers per liter of air," abbreviated as f/l. This unit tells how much asbestos there is in one liter of air.

WHAT SHOULD I DO IF I HAVE AN ASBESTOS PROBLEM?

If you discover that you have an asbestos problem, the best thing to do is to contact a contractor who has experience in the proper procedures for repairing and removing asbestos. There are special guidelines for handling asbestos-containing materials. You should avoid drilling, scraping, sanding, brushing, sweeping or vacuuming asbestos materials. This will disturb tiny asbestos fibers, make them airborne, and increase the risk of breathing them. It is highly recommended that you hire an experienced contractor or get professional advice if you are thinking of doing the work yourself. A contractor will seal off the contaminated area from the rest of the house and workers will use protective clothing and a special respirator while they are handling the asbestos. Using improper techniques can make an existing problem much worse by contaminating the entire house. For more information about identifying, testing, handling, and fixing asbestos problems call the New Jersey Department of Health toll-free at 1-800-624-2376.

INTERPRETING YOUR TEST RESULT:

The U. S. Environmental Protection Agency has evaluated the risk from asbestos. The following statement about the EPA regulation for schools and public buildings can help you interpret your own (imaginary) asbestos test result:

> **A home level of 3 f/l or above corresponds to the risk at which EPA requires action in schools and public buildings.**

wall, you should have the material analyzed to determine if it contains asbestos. Laboratory analyses range from about $20 to $40 per sample. Several samples may be required to gain an accurate determination of asbestos content.

If you suspect that you have a problem, you may also want to have an air sample taken to measure the amount of asbestos fibers circulating inside your home. To collect the sample, a laboratory will send a technician to your home. A pump is used to draw air from the room into a filter that will trap the asbestos. An electron microscope is used to count the number of fibers trapped in the filter. It takes about six hours to collect the sample and costs between $100 and $400, depending on the laboratory and technique used. The results of the test can be reported in units of "fibers per liter of air," abbreviated as f/l. This unit tells how much asbestos there is in one liter of air.

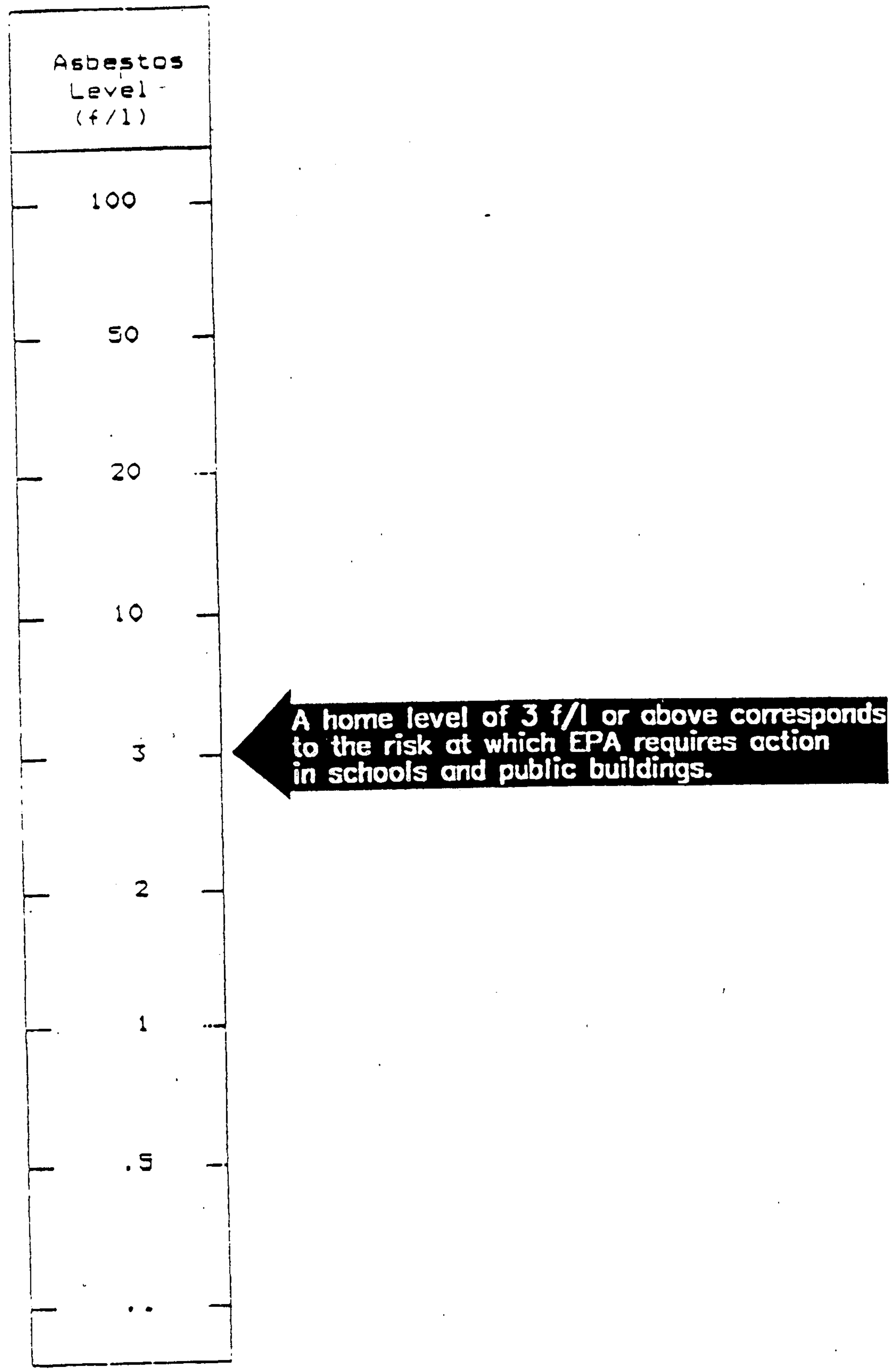
WHAT SHOULD I DO IF I HAVE AN ASBESTOS PROBLEM?

If you discover that you have an asbestos problem, the best thing to do is to contact a contractor who has experience in the proper procedures for repairing and removing asbestos. There are special guidelines for handling asbestos-containing materials. You should avoid drilling, scraping, sanding, brushing, sweeping or vacuuming asbestos materials. This will disturb tiny asbestos fibers, make them airborne, and increase the risk of breathing them. It is highly recommended that you hire an experienced contractor or get professional advice if you are thinking of doing the work yourself. A contractor will seal off the contaminated area from the rest of the house and workers will use protective clothing and a special respirator while they are handling the asbestos. Using improper techniques can make an existing problem much worse by contaminating the entire house. For more information about identifying, testing, handling, and fixing asbestos problems call the N. J. Department of Health toll-free at 1-800-624-2376.

INTERPRETING YOUR TEST RESULT:

Using the imaginary test result we have given you, look down the column on the next page headed "Asbestos Level," and find the level nearest to your test result. The U. S. Environmental Protection Agency has evaluated the risk from asbestos and has issued a regulation for schools and public buildings that can help you interpret your asbestos test result. The arrow to the right of the column gives information about this EPA action guideline.

INTERPRETING YOUR TEST RESULT:



EXPERIMENT I
FEEDBACK QUESTIONNAIRE

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Cook College · Department of Human Ecology
P.O. Box 231 · New Brunswick · New Jersey 08903 · 201/932-9153

Dear New Jersey Resident:

Thank you for talking with us on the phone and for agreeing to take part in our project. At Rutgers we are developing different information brochures for people who test their homes for asbestos. The feedback questionnaire you return will show us whether the brochure we sent you is helpful.

There are no right or wrong answers. We need to get <u>your</u> reactions and <u>your</u> opinions to evaluate the brochure. All your answers are kept confidential. The code number on the feedback questionnaire is only used to show us which questionnaires have been returned, so we don't call and remind people who have already mailed back their answers.

DIRECTIONS

Pretend that you have just had your house tested for asbestos. The testing company tells you that you have a reading of __________ **fibers per liter on your first floor** and you are trying to decide whether you should do anything about it. Read the "Test Brochure" to help you interpret your imaginary test result and then fill out the questionnaire. FEEL FREE TO REFER TO THE BROCHURE WHEN ANSWERING THE FEEDBACK QUESTIONS. When you have finished, mail the questionnaire back to us in the envelope that we have provided. The Test Brochure is yours to keep.

THANK YOU VERY MUCH FOR YOUR HELP.

Sincerely,

Neil D Weinstein Paul M Miller

Neil D. Weinstein, Professor
Peter M. Sandman, Professor
Paul M. Miller, Project Director

FEEDBACK QUESTIONNAIRE

We appreciate your help in filling out this questionnaire because this is the only way we can find out whether the brochure has been successful in explaining your risk. Feel free to look back at the brochure when answering the questions.

```
*****************************************************
*                                                   *
*   Your imaginary asbestos                         *
*   test result on your                             *
*         main floor is:                            *
*                                                   *
*                           fibers/liter (f/l)      *
*                                                   *
*   Use this level when answering questions         *
*   about how serious a problem you have.           *
*                                                   *
*****************************************************
```

Overall, how would you rate the brochure we sent you? (Please circle one answer in each row.)

1. very difficult to understand | fairly difficult to understand | fairly easy to understand | very easy to understand

2. didn't help me understand my test result | a little helpful for understanding my test result | moderately helpful for understanding my test result | very helpful for understanding my test result

3. much too little information | too little information | about right | too much information | much too much information

4. Did the brochure give you a good understanding of the risk from your asbestos level?
   [ ] I have a very good understanding of the risk
   [ ] I have a fairly good understanding of the risk
   [ ] I feel fairly uncertain about the risk
   [ ] I feel very uncertain about the risk

5. How would you describe the danger from your (imaginary) asbestos level?
   [ ] no danger
   [ ] very slight danger
   [ ] slight danger
   [ ] moderate danger
   [ ] serious danger
   [ ] very serious danger

F2C

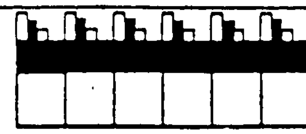
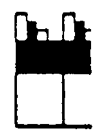
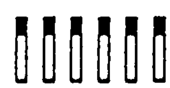
EXPERIMENT II
FORMAT PAGE
DISPLACED CONDITION

INTERPRETING YOUR TEST RESULT:

Asbestos level (f/l)	Extra Cancer Deaths (Out of 1000 People)	Comparison to Smoking Risk
75	15 in 1000	6 cigarettes/ day
35	7 in 1000	
15	3 in 1000	1 cigarette/ day
7.5	1.5 in 1000	
3.5	.7 in 1000	1/4 cigarette/ day
1.5	.3 in 1000	
.75	.15 in 1000	1/10 cigarette/ day
.35	.07 in 1000	
.15	.03 in 1000	1/100 cigarette/ day

EXPERIMENT II
FORMAT PAGE
HIGH TEST CONDITION

INTERPRETING YOUR TEST RESULT:

Asbestos level (f/cubic foot)	Extra Cancer Deaths (Out of 1000 People)	Comparison to Smoking Risk
45,000	300 in 1000	 6 packs/ day
22,500	150 in 1000	
10,500	70 in 1000	 1 1/2 packs/ day
4,500	30 in 1000	
2,250	15 in 1000	 6 cigarettes/ day
1,050	7 in 1000	
450	3 in 1000	 1 cigarette/ day
225	1.5 in 1000	
105	.7 in 1000	 1/4 cigarette/ day

[illegible]

FEEDBACK QUESTIONNAIRE

BASE AND DISPLACED CONDITIONS

THE STATE UNIVERSITY OF NEW JERSEY

RUTGERS

Cook College · Department of Human Ecology
P.O. Box 231 · New Brunswick · New Jersey 08903 · 201 932-9153

Dear New Jersey Resident:

Thank you for talking with us on the phone and for agreeing to take part in our project. At Rutgers we are developing different information brochures for people who test their homes for asbestos. The feedback questionnaire you return will show us whether the brochure we sent you is helpful.

There are no right or wrong answers. We need to get <u>your</u> reactions and <u>your</u> opinions to evaluate the brochure. All your answers are kept confidential. The code number on the feedback questionnaire is only used to show us which questionnaires have been returned, so we don't call and remind people who have already mailed back their answers.

DIRECTIONS

Pretend that you have just had your house tested for asbestos. The testing company tells you that you have a reading of _________ **fibers per liter on your first floor** and you are trying to decide whether you should do anything about it. Read the "Test Brochure" to help you interpret your imaginary test result and then fill out the questionnaire. FEEL FREE TO REFER TO THE BROCHURE WHEN ANSWERING THE FEEDBACK QUESTIONS. When you have finished, mail the questionnaire back to us in the envelope that we have provided. The Test Brochure is yours to keep.

THANK YOU VERY MUCH FOR YOUR HELP.

Sincerely,

Neil Weinstein Paul M Miller

Neil D. Weinstein, Professor
Peter M. Sandman, Professor
Paul M. Miller, Project Director

FEEDBACK QUESTIONNAIRE

We appreciate your help in filling out this questionnaire because this is the only way we can find out whether the brochure has been successful in explaining your risk. Feel free to look back at the brochure when answering the questions.

```
*****************************************************
*                                                   *
*   Your imaginary asbestos                         *
*   test result on your                             *
*        main floor is:                             *
*                         fibers per    liter       *
*                         (f/ l)                    *
*                                                   *
*   Use this level when answering questions         *
*   about how serious a problem you have.           *
*                                                   *
*****************************************************
```

Overall, how would you rate the brochure we sent you? (Please circle one answer in each row.)

1.	very difficult to understand	fairly difficult to understand	fairly easy to understand	very easy to understand	
2.	didn t help me understand my test result	a little helpful for understanding my test result	moderately helpful for understanding my test result	very helpful for understanding my test result	
3.	much too little information	too little information	about right	too much information	much too much information

4. Did the brochure give you a good understanding of the risk from your asbestos level?
   [ ] I have a very good understanding of the risk
   [ ] I have a fairly good understanding of the risk
   [ ] I feel fairly uncertain about the risk
   [ ] I feel very uncertain about the risk

5. How would you describe the danger from your (imaginary) asbestos level?
   [ ] no danger
   [ ] very slight danger
   [ ] slight danger
   [ ] moderate danger
   [ ] serious danger
   [ ] very serious danger

6. If you continued to live in the home with your test result and didn't do anything about the asbestos, what do you think are the chances that you would eventually have some illness due to asbestos? (Even though you may feel uncertain, please circle an answer to tell us what impression you got from the brochure.)

no chance	very unlikely	unlikely	moderate chance	likely	very likely	certain to happen

How do you think you would feel if your own home actually had the asbestos level found by the imaginary test? (Please circle one answer in each row.)

7.	not at all concerned	slightly concerned	concerned	very concerned	extremely concerned
8.	not at all frightened	slightly frightened	frightened	very frightened	extremely frightened

9. What is your impression of how difficult it is to reduce the asbestos level if houses have a problem?
   [ ] very difficult
   [ ] fairly difficult
   [ ] fairly easy
   [ ] very easy

10. Let's say that reducing your asbestos level close to zero would cost a thousand dollars ($1000). Given what you have learned about the size of your present risk, do you think you would decide to carry out asbestos reduction measures?
   [ ] definitely would take measures to reduce the asbestos level
   [ ] probably would take measures
   [ ] cannot decide what to do
   [ ] probably would NOT take measure
   [ ] definitely would NOT take measures

11. If you continued to live in the home with your test result and didn't do anything about the asbestos, what do you think are the odds that you would eventually have some illness due to asbestos? (Please put a check in the box that comes closest to your opinion.)

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
no chance		1 chance in 1,000 (0.1%)		1 chance in 100 (1%)		1 chance in 10 (10%)		certain (100%)	no idea

12. At what asbestos level (in your main living area) do you think you would feel satisfied, so that you would not spend more money trying to get the level even lower?

[ ] NO asbestos	[ ] 7.5 fibers/liter
[ ] .15 fibers/liter	[ ] 15 fibers/liter
[ ] .35 fibers/liter	[ ] 35 fibers/liter
[ ] .75 fibers/liter	[ ] 75 fibers/liter
[ ] 1.5 fibers/liter	[ ] 150 fibers/liter
[ ] 3.5 fibers/liter	[ ] 350 fibers/liter

For classification purposes, please tell us:

a. Your sex: [ ] male [ ] female

b. Your age: ___________

c. How much school have you completed?

[ ] some elementary school	[ ] finished 2-year college
[ ] finished elementary school	[ ] finished 4-year college
[ ] some high school	[ ] some graduate study
[ ] finished high school	[ ] graduate degree
[ ] some college	

d. Prior to receiving our brochure, how much had you read about asbestos:

- [ ] very little
- [ ] small amount
- [ ] moderate amount (at least one information booklet or a magazine article)
- [ ] a lot

e. Have you tested your own house, condominium or apartment for asbestos:

- [ ] no
- [ ] yes

f. Have you heard of any government standard or "action level" for asbestos in homes:

- [ ] no
- [ ] yes -----> What do you think is the government action level:
  Level is: _________ [ ] don't know

THANK YOU FOR YOUR TIME AND HELP!
If you want a copy of some of the other brochures we're testing, please fill out the mailing label and include it in the envelope when you mail back the questionnaire.

12. At what asbestos level (in your main living area) do you think you would feel satisfied, so that you would not spend more money trying to get the level even lower?

[ ] NO asbestos
[ ] .15 fibers/deciliter
[ ] .35 fibers/deciliter
[ ] .75 fibers/deciliter
[ ] 1.5 fibers/deciliter
[ ] 3.5 fibers/deciliter
[ ] 7.5 fibers/deciliter
[ ] 15 fibers/deciliter
[ ] 35 fibers/deciliter
[ ] 75 fibers/deciliter
[ ] 150 fibers/deciliter
[ ] 350 fibers/deciliter

For classification purposes, please tell us:

a. Your sex: [ ] male [ ] female

b. Your age: __________

c. How much school have you completed?

[ ] some elementary school
[ ] finished elementary school
[ ] some high school
[ ] finished high school
[ ] some college
[ ] finished 2-year college
[ ] finished 4-year college
[ ] some graduate study
[ ] graduate degree

d. Prior to receiving our brochure, how much had you read about asbestos:

[ ] very little
[ ] small amount
[ ] moderate amount (at least one information booklet or a magazine article)
[ ] a lot

e. Have you tested your own house, condominium or apartment for asbestos:

[ ] no
[ ] yes

f. Have you heard of any government standard or "action level" for asbestos in homes:

[ ] no
[ ] yes -----> What do you think is the government action level:
Level is: ________ [ ] don't know

THANK YOU FOR YOUR TIME AND HELP!
If you want a copy of some of the other brochures we're testing, please fill out the mailing label and include it in the envelope when you mail back the questionnaire.

EXPERIMENT II
FEEDBACK QUESTIONNAIRE
HIGH TEST CONDITION PAGE

12. At what asbestos level (in your main living area) do you think you would feel satisfied, so that you would not spend more money trying to get the level even lower?

[ ] NO asbestos	[ ] 225 fibers/cubic ft
[ ] 4.5 fibers/cubic ft	[ ] 450 fibers/cubic ft
[ ] 10.5 fibers/cubic ft	[ ] 1050 fibers/cubic ft
[ ] 22.5 fibers/cubic ft	[ ] 2250 fibers/cubic ft
[ ] 45.0 fibers/cubic ft	[ ] 4500 fibers/cubic ft
[ ] 105 fibers/cubic ft	[ ] 10500 fibers/cubic ft

For classification purposes, please tell us:

a. Your sex: [ ] male [ ] female

b. Your age: __________

c. How much school have you completed?

[ ] some elementary school
[ ] finished elementary school
[ ] some high school
[ ] finished high school
[ ] some college
[ ] finished 2-year college
[ ] finished 4-year college
[ ] some graduate study
[ ] graduate degree

d. Prior to receiving our brochure, how much had you read about asbestos:

[ ] very little
[ ] small amount
[ ] moderate amount (at least one information booklet or a magazine article)
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e. Have you tested your own house, condominium or apartment for asbestos:

[ ] no
[ ] yes

f. Have you heard of any government standard or "action level" for asbestos in homes:

[ ] no
[ ] yes ------> What do you think is the government action level:
Level is: ________ [ ] don't know

THANK YOU FOR YOUR TIME AND HELP!
If you want a copy of some of the other brochures we're testing, please fill out the mailing label and include it in the envelope when you mail back the questionnaire.

APPENDIX C

EXPERIMENT III BROCHURES, FORMATS, AND QUESTIONNAIRES

Experiment III had five conditions: Joint Radon and Asbestos, Base Radon, Base Asbestos, High Risk Asbestos, and Displaced Asbestos. The Appendix begins with the two two-page brochures that were used, one for radon and one for asbestos (subjects in the Joint condition received both brochures). There are six format pages: two versions of the Joint format page (one with asbestos first and one with radon first), followed by the Base Radon, Base Asbestos, High Risk Asbestos, and Displaced Asbestos format pages, in that order. Next comes the six-page response questionnaire used for the Joint condition (a one-page cover letter, two pages on radon, two pages on asbestos, and one page of demographic items). The other four conditions used the same questionnaire, but with either the two radon pages or the two asbestos pages omitted. The alternative cover letters used for the Base Radon condition and the various asbestos conditions are provided at the end of the Appendix.

Test Brochure*

4/90

BASIC RADON INFORMATION

WHAT IS RADON?

Radon is a radioactive gas that occurs in nature. It has no color, odor, or taste. Radon comes from the natural breakdown (radioactive decay) of the uranium present in rocks and soil. This is not an unusual situation; rocks and soil often contain small amounts of uranium. Radon can move through the soil into the open air.

WHY THE CONCERN ABOUT RADON?

Exposure to elevated levels of radon increases the risk of lung cancer. Radon is not known to cause any other health problem, except lung cancer. Not everyone exposed to elevated levels of radon will develop lung cancer. Still, in some houses the level of risk is very high. Studies suggest that between 5,000 and 30,000 lung cancer deaths a year in the United States are caused by radon.

The time between the exposure and the onset of the disease may be many years. There are no symptoms or early-warning signs to tell you that you have a high radon level in your home.

The risk increases as the level of radon and the length of exposure increase. Therefore, exposure to a low level for a long time may present a greater chance of cancer than exposure to a higher level for a short time.

HOW DOES RADON AFFECT US?

Radon naturally breaks down and forms decay products that cling to dust and other particles in the air. As we breathe, these particles can become trapped in our lungs with the radon decay products still attached. As these trapped radon products decay further, they release small bursts of radiation that can damage lung tissue and lead to lung cancer.

HOW DOES RADON ENTER A HOME?

Outdoors, radon from the soil mixes with the rest of the air. This mixing dilutes the radon, producing concentrations that are usually quite low. Inside an enclosed space there is usually less fresh air to dilute the radon. Therefore, radon inside a home can accumulate, and sometimes it reaches dangerous levels. Homes that are airtight hold radon longer and prevent fresh outside air from entering the home. On the other hand, keeping windows open and ventilating will usually lower the concentration of radon in the air inside the home.

Radon can seep into a home through any opening in the walls or floor of the foundation, openings around pipes, sump pump holes, and unpaved crawl spaces. Radon can also enter the water of private wells and be released into a home when the water is used. This is not usually a problem with public water supplies, because the radon would probably be released into the outside air during treatment before the water ever reached the home.

* Because this is an experimental brochure, please check with other authorities before taking any action in your home.

HOW IS RADON DETECTED?

Since you cannot see or smell radon, special equipment is needed to detect it. The devices that may be used to determine if your home has high radon levels include the alpha-track detector, the charcoal canister, and others. The first two devices are very simple to use. They involve removing the seal or top of a small canister and placing the canister on a shelf or table in the area you want to test. By removing the seal a special material is exposed which will register the amount of radon in the air. After the prescribed amount of time (several days to several months) you simply replace the top of the canister and mail it to the laboratory for analysis. Typical costs range from $12 to $50 per test. Because radon levels in a home often vary from day to day, measurements over a brief time period give only a rough indication of the situation.

If your home was tested with a charcoal or alpha-track detector, the results will probably be reported in units of "picocuries per liter of air," abbreviated as pCi/l. This unit tells how much radon there is in one liter of air.

IS IT DANGEROUS IF I FIND I HAVE HIGH LEVELS?

Radon is a serious risk. There is no level of exposure to radon in the home that experts can agree is completely safe. The chances of suffering harm from elevated radon levels are much greater than the chances of suffering harm from most other pollution problems. As Consumer Reports has stated, "While there are uncertainties in pinpointing low-level radon risks, there is no doubt that the risks of radon vastly exceed the risks from aflatoxin, PCBs, nuclear wastes, and virtually all other environmental hazards" (July 1987, p. 442). The disease caused by radon, lung cancer, is incurable and almost always fatal. For these reasons it is important to identify radon problems and take steps to reduce your exposure before any illness occurs.

CAN I DO ANYTHING IF I HAVE HIGH RADON LEVELS AT HOME?

Even very high radon concentrations can be lowered. On a short-term basis, just keeping windows open will usually substantially lower the radon level. But this is too expensive to continue during the heating season. Other, more permanent methods are described in a booklet entitled "Radon Reduction Methods: A Homeowner's Guide" that is available from the New Jersey Department of Environmental Protection radon information line, 1-800-648-0394.

INTERPRETING YOUR TEST RESULT:

Use the chart on the last page of this brochure to interpret the imaginary test result we gave you. First, look down the left-hand column headed "Radon Level," and find the number nearest to your radon test result.

Next, move toward the right to the middle column headed "Extra Cancer Deaths." The number in this column tells you how many people are expected to die of cancer because of radon out of every 1000 people who live in a home with the same radon level as yours.

Finally, move over to the right-hand column entitled "Comparison to Smoking Risk." It tells you how many cigarettes a day a person would have to smoke to have the same cancer risk as living with your radon level.

Test Brochure*

4/90

BASIC ASBESTOS INFORMATION

WHAT IS ASBESTOS?

Asbestos is a mineral fiber found in rocks. There are several kinds of asbestos fibers, all of which are fire-resistant and not easily destroyed by natural processes. Because of its desirable qualities, asbestos has been used in a wide variety of products including appliances, ceilings, wall and pipe coverings, floor tiles, and some roofing materials.

WHY THE CONCERN ABOUT ASBESTOS?

Although asbestos has many benefits for humans, it is also a very dangerous mineral. Breathing airborne asbestos fibers has been shown to cause: (1) Asbestosis - a serious lung disease which can lead to disability and death; (2) Lung cancer - a disease that is incurable and almost always fatal; and (3) Mesothelioma - cancer of the lining of the lungs or abdominal cavities. The greater the exposure to asbestos, the more likely it is that one of these serious diseases will develop. Workers who handle or come into contact with asbestos on a daily basis are open to the greatest health risks.

There is no level of exposure to asbestos fibers that is completely safe. The greater the concentration of asbestos, and the longer the exposure, the greater the risk.

HOW DOES ASBESTOS AFFECT US?

The danger arises when the asbestos fibers are released from the product or material. These fibers are so small that they cannot be seen. They can float in the air for a long time and can pass through the filters of normal vacuum cleaners and get back into the air. Once inhaled, asbestos fibers can become lodged in tissue for a long time. After many years cancer or asbestosis can develop. Cigarette smoking combined with asbestos exposure is especially hazardous.

Asbestos found in "friable" materials is most dangerous. Friable materials are materials that can be crumbled, pulverized, or reduced to powder by hand pressure. Asbestos insulation sprayed on a ceiling is an example of a friable material. In contrast, vinyl asbestos floor tile is not usually friable. The asbestos fibers are firmly bound or sealed into the tile and can be released into the air only if the tile is cut, ground, or sanded.

WHERE IS ASBESTOS LIKELY TO BE FOUND IN THE HOME?

There are several areas in the home where asbestos problems are most likely to arise. These include:

- Wall construction material and pipe insulation, especially those dating between 1920 and 1972.
- Friable ceilings in buildings built or remodeled between 1945 and 1978.
- Material found in stoves and furnaces such as insulation and door gaskets.

* Because this is an experimental brochure, please check with other authorities before taking any action in your home.

Other asbestos-containing products that you may find in the home include:

* Patching compounds and textured paints (applied prior to 1975).
* Vinyl floor tiles and flooring.
* Roofing, shingles, and siding.
* Appliances with asbestos-containing parts or components, such as toasters, broilers, slow cookers, dishwashers, refrigerators, ovens, ranges, and clothes dryers.

Having significant amounts of asbestos in the home is not rare. Many old homes in New Jersey could create health problems for residents because of materials that may release asbestos fibers into the air.

HOW CAN I TELL IF I HAVE ASBESTOS IN MY HOME?

People who have worked frequently with asbestos (such as plumbers, and building or heating contractors) can often tell you whether or not material contains asbestos by looking at it.

If you suspect that you have a problem, you may also want to have an air sample taken to measure the number of asbestos fibers circulating inside your home. To collect the sample, a laboratory will send a technician to your home. A pump is used to draw air from the room into a filter that will trap the asbestos. An electron microscope is used to count the sample. The test costs between $100 and $400, depending upon the laboratory technique used. The results of the test can be reported in units of "fibers per deciliter of air," abbreviated as f/dl. This unit tells how much asbestos there is in one deciliter (one-tenth of a liter) of air.

WHAT SHOULD I DO IF I HAVE AN ASBESTOS PROBLEM?

If you discover that you have an asbestos problem, the best thing to do is to contact a contractor who has experience in the proper procedures for repairing and removing asbestos. There are special guidelines for handling asbestos-containing materials. It is highly recommended that you hire an experienced contractor or get professional advice if you are thinking of doing the work yourself. Using improper techniques can make an existing problem much worse by contaminating the entire house. For more information about identifying, testing, handling, and fixing asbestos problems call the N.J. Department of Health toll-free at 1-800-624-2376.

INTERPRETING YOUR TEST RESULT:

Use the chart on the last page of this brochure to interpret the imaginary test result we gave you. First, look down the left-hand column headed "Asbestos Level," and find the number nearest to your asbestos test result.

Next, move toward the right to the middle column headed "Extra Cancer Deaths." The number in this column tells you how many people are expected to die of cancer because of asbestos out of every 1000 people who live in a home with the same asbestos level as yours.

Finally, move over to the right-hand column entitled "Comparison to Smoking Risk." It tells you how many cigarettes a day a person would have to smoke to have the same cancer risk as living with your asbestos level.

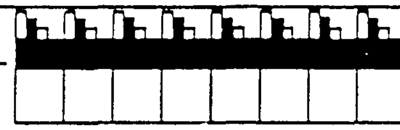
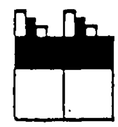
INTERPRETING YOUR TEST RESULT:

Asbestos level (fibers/ liter)	Radon level (pCi/ liter)	Extra Cancer Deaths (out of 1000 people)	Comparison to Smoking Risk
2000	80	400 in 1000	8 packs/ day
1000	40	200 in 1000	
500	20	100 in 1000	2 packs/ day
250	10	50 in 1000	
120	5	25 in 1000	10 cigarettes/ day
60	2.5	12 in 1000	
30	1.2	6 in 1000	2 1/2 cigarettes/ day
15	.6	3 in 1000	
8	.3	1.5 in 1000	1/2 cigarette/ day

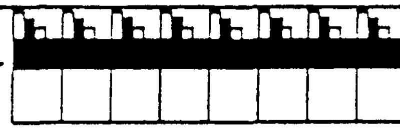
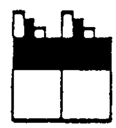
INTERPRETING YOUR TEST RESULT:

Radon level (pCi/ liter)	Asbestos level (fibers/ liter)	Extra Cancer Deaths (out of 1000 people)	Comparison to Smoking Risk
80	2000	400 in 1000	8 packs/ day
40	1000	200 in 1000	
20	500	100 in 1000	2 packs/ day
10	250	50 in 1000	
5	120	25 in 1000	10 cigarettes/ day
2.5	60	12 in 1000	
1.2	30	6 in 1000	2 1/2 cigarettes/ day
.6	15	3 in 1000	
.3	8	1.5 in 1000	1/2 cigarette/ day

INTERPRETING YOUR TEST RESULT:

Radon level (pCi/ liter)	Extra Cancer Deaths (out of 1000 people)	Comparison to Smoking Risk
80	400 in 1000	 8 packs/ day
40	200 in 1000	
20	100 in 1000	 2 packs/ day
10	50 in 1000	
5	25 in 1000	 10 cigarettes/ day
2.5	12 in 1000	
1.2	6 in 1000	 2 1/2 cigarettes/ day
.6	3 in 1000	
.3	1.5 in 1000	 1/2 cigarette/ day

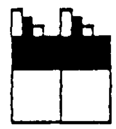
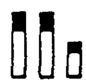
INTERPRETING YOUR TEST RESULT:

Asbestos level (fibers/ liter)	Extra Cancer Deaths (out of 1000 people)	Comparison to Smoking Risk
2000	400 in 1000	 8 packs/ day
1000	200 in 1000	
500	100 in 1000	 2 packs/ day
250	50 in 1000	
120	25 in 1000	 10 cigarettes/ day
60	12 in 1000	
30	6 in 1000	 2 1/2 cigarettes/ day
15	3 in 1000	
8	1.5 in 1000	 1/2 cigarette/ day

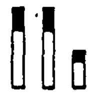
D

EXPERIMENT III
HIGH RISK ASBESTOS FORMAT PAGE

INTERPRETING YOUR TEST RESULT:

Asbestos level (fibers/ deciliter)	Extra Cancer Deaths (out of 1000 people)	Comparison to Smoking Risk
200	400 in 1000	 8 packs/ day
100	200 in 1000	
50	100 in 1000	 2 packs/ day
25	50 in 1000	
12	25 in 1000	 10 cigarettes/ day
6	12 in 1000	
3	6 in 1000	 2 1/2 cigarettes/ day
1.5	3 in 1000	
.8	1.5 in 1000	 1/2 cigarette/ day

INTERPRETING YOUR TEST RESULT:

Asbestos level (fibers/ liter)	Extra Cancer Deaths (out of 1000 people)	Comparison to Smoking Risk
60	12 in 1000	
30	6 in 1000	 2 1/2 cigarettes/ day
15	3 in 1000	
8	1.5 in 1000	 1/2 cigarette/ day
4	.8 in 1000	
2	.4 in 1000	 1/8 cigarette/ day
1	.2 in 1000	
.5	.1 in 1000	1/30 cigarette/ day
.3	.05 in 1000	

EXPERIMENT III

Feedback Questionnaire

THE STATE UNIVERSITY OF NEW JERSEY

RUTGERS

Cook College · Department of Human Ecology
P.O. Box 231 · New Brunswick · New Jersey 08903 · 201 932-9153

Dear New Jersey Resident:

Thank you for talking with us on the phone and for agreeing to take part in our project. At Rutgers we are developing different information brochures for people who test their homes for radon or asbestos. The feedback questionnaire you return will show us whether the brochures we sent you are helpful.

There are no right or wrong answers. We need to get <u>your</u> reactions and <u>your</u> opinions to evaluate the brochures. All your answers are kept confidential. The code number on the feedback questionnaire is only used to show us which questionnaires have been returned, so we don't call and remind people who have already mailed back their answers.

DIRECTIONS

Pretend that you have just had your house tested for asbestos and radon. The testing company tells you that you have the following readings on your first floor and you are trying to decide whether you should do anything about it.

asbestos __________ **fibers per liter**

radon __________ **picocuries per liter**

Read the "Test Brochures" to help you interpret your imaginary test results and then fill out the questionnaire. FEEL FREE TO REFER TO THE BROCHURES WHEN ANSWERING THE FEEDBACK QUESTIONS. When you have finished, mail the questionnaire back to us in the envelope that we have provided. The Test Brochures are yours to keep.

THANK YOU VERY MUCH FOR YOUR HELP.

Sincerely,

Neil Weinstein Paul M Miller

Neil D. Weinstein, Professor
Peter M. Sandman, Professor
Paul M. Miller, Project Director

THE QUESTIONS ON THIS PAGE ARE FOR RADON.

FEEDBACK QUESTIONNAIRE

> Your imaginary radon test result on your main floor is:
>
> picocuries/liter (pCi/l)
>
> Use this level when answering questions about how serious a problem you have.

Overall, how would you rate the information about radon we sent you? (Please circle one answer in each row.)

1.	very difficult to understand	fairly difficult to understand	fairly easy to understand	very easy to understand
2.	didn't help me understand my test result	a little helpful for understanding my test result	moderately helpful for understanding my test result	very helpful for understanding my test result

3. How would you describe the danger from your (imaginary) radon level? (Please check one box to indicate your feelings.)

   [ ] no danger
   [ ] very slight danger
   [ ] slight danger
   [ ] moderate danger
   [ ] serious danger
   [ ] very serious danger

4. How likely do you think it is that continued exposure to your imaginary radon level would eventually have harmful effects? (Even though you may feel uncertain, please circle an answer to tell us what impression you got from the information we sent you.)

no chance	very unlikely	unlikely	moderate chance	likely	very likely	certain to happen

How do you think you would feel if your own home actually had the radon level found by the imaginary test? (Please circle one answer in each row.)

5.	not at all concerned	slightly concerned	moderately concerned	very concerned	extremely concerned
6.	not at all frightened	slightly frightened	moderately frightened	very frightened	extremely frightened

THE QUESTIONS ON THIS PAGE ARE FOR RADON.

7. Let's say that reducing your imaginary radon level close to zero would cost a thousand dollars ($1000). Given what you have learned about the size of the risk, do you think you would decide to carry out radon reduction measures?

[ ] definitely would reduce the level
[ ] probably would reduce the level
[ ] cannot decide what to do
[ ] probably would NOT reduce the level
[ ] definitely would NOT reduce the level

8. If someone lived in the home with your imaginary test result and did nothing about the radon, what do you think are the chances that s/he would eventually have some illness due to radon? (Please check the box that comes closest to your opinion.)

[ ] no chance	[ ] 10 chances in 1,000
[ ] .1 chance in 1,000	[ ] 20 chances in 1,000
[ ] .2 chance in 1,000	[ ] 40 chances in 1,000
[ ] .5 chance in 1,000	[ ] 80 chances in 1,000
[ ] 1 chance in 1,000	[ ] 120 chances in 1,000
[ ] 2 chances in 1,000	[ ] 250 chances in 1,000
[ ] 5 chances in 1,000	[ ] don't know

For questions 9-13 below please check the box that best indicates your impression about radon. For example, in the sample item below, if your impression was that radon was very often found in homes, but not always, then you would check the box shown below.

Sample Question: How frequently is radon found in homes?

never [ ] [ ] [ ] [ ] [ ] [X] [ ] always

9. How easily can radon levels be reduced?

very easy to reduce [ ] [ ] [ ] [ ] [ ] [ ] [ ] very difficult to reduce

10. Is radon a risk that people can think about reasonably calmly, or is it one that people have great dread for--on the level of a gut reaction?

calm reaction [ ] [ ] [ ] [ ] [ ] [ ] [ ] dread risk

11. If someone became sick because of radon, how likely is it that the illness would be fatal?

certain <u>not</u> to be fatal [ ] [ ] [ ] [ ] [ ] [ ] [ ] certain to be fatal

12. Is radon a risk that is new and novel or old and familiar?

old [ ] [ ] [ ] [ ] [ ] [ ] [ ] new

13. To what extent are the risks from radon the result of natural processes, or are the risks man-made?

all man-made [ ] [ ] [ ] [ ] [ ] [ ] [ ] all natural

THE QUESTIONS ON THIS PAGE ARE FOR ASBESTOS.

FEEDBACK QUESTIONNAIRE

```
*******************************************************
*                                                     *
*   Your imaginary asbestos                           *
*   test result on your                               *
*        main floor is:                               *
*                                                     *
*                        fibers/liter (f/l)           *
*                                                     *
*   Use this level when answering questions           *
*   about how serious a problem you have.             *
*                                                     *
*******************************************************
```

Overall, how would you rate the information about asbestos we sent you? (Please circle one answer in each row.)

1.	very difficult to understand	fairly difficult to understand	fairly easy to understand	very easy to understand
2.	didn't help me understand my test result	a little helpful for understanding my test result	moderately helpful for understanding my test result	very helpful for understanding my test result

3. How would you describe the danger from your (imaginary) asbestos level? (Please check one box to indicate your feelings.)

   [ ] no danger
   [ ] very slight danger
   [ ] slight danger
   [ ] moderate danger
   [ ] serious danger
   [ ] very serious danger

4. How likely do you think it is that continued exposure to your imaginary asbestos level would eventually have harmful effects? (Even though you may feel uncertain, please circle an answer to tell us what impression you got from the information we sent you.)

no chance	very unlikely	unlikely	moderate chance	likely	very likely	certain to happen

How do you think you would feel if your own home actually had the asbestos level found by the imaginary test? (Please circle one answer in each row.)

5.	not at all concerned	slightly concerned	moderately concerned	very concerned	extremely concerned
6.	not at all frightened	slightly frightened	moderately frightened	very frightened	extremely frightened

(Over)

THE QUESTIONS ON THIS PAGE ARE FOR ASBESTOS.

7. Let's say that reducing your imaginary asbestos level close to zero would cost a thousand dollars ($1000). Given what you have learned about the size of the risk, do you think you would decide to carry out asbestos reduction measures?

[ ] definitely would reduce the level
[ ] probably would reduce the level
[ ] cannot decide what to do
[ ] probably would NOT reduce the level
[ ] definitely would NOT reduce the level

8. If someone lived in the home with your imaginary test result and did nothing about the asbestos, what do you think are the chances that s/he would eventually have some illness due to asbestos? (Please check the box that comes closest to your opinion.)

[ ] no chance
[ ] .1 chance in 1,000
[ ] .2 chance in 1,000
[ ] .5 chance in 1,000
[ ] 1 chance in 1,000
[ ] 2 chances in 1,000
[ ] 5 chances in 1,000
[ ] 10 chances in 1,000
[ ] 20 chances in 1,000
[ ] 40 chances in 1,000
[ ] 80 chances in 1,000
[ ] 120 chances in 1,000
[ ] 250 chances in 1,000
[ ] don't know

For questions 9-13 below please check the box that best indicates your impression about asbestos. For example, in the sample item below, if your impression was that asbestos was very often found in homes, but not always, then you would check the box shown below.

Sample Question: **How frequently is asbestos found in homes?**

never [ ] [ ] [ ] [ ] [ ] [X] [ ] always

9. How easily can asbestos levels be reduced?

very easy to reduce [ ] [ ] [ ] [ ] [ ] [ ] [ ] very difficult to reduce

10. Is asbestos a risk that people can think about reasonably calmly, or is it one that people have great dread for--on the level of a gut reaction?

calm reaction [ ] [ ] [ ] [ ] [ ] [ ] [ ] dread risk

11. If someone became sick because of asbestos, how likely is it that the illness would be fatal?

certain <u>not</u> to be fatal [ ] [ ] [ ] [ ] [ ] [ ] [ ] certain to be fatal

12. Is asbestos a risk that is new and novel or old and familiar?

old [ ] [ ] [ ] [ ] [ ] [ ] [ ] new

13. To what extent are the risks from asbestos the result of natural processes, or are the risks man-made?

all man-made [ ] [ ] [ ] [ ] [ ] [ ] [ ] all natural

For classification purposes, please tell us:

a. Your sex: [ ] male [ ] female

b. Your age: ________

c. How much school have you completed?

[ ] some elementary school
[ ] finished elementary school
[ ] some high school
[ ] finished high school
[ ] some college
[ ] finished 2-year college
[ ] finished 4-year college
[ ] some graduate study
[ ] graduate degree

d. Have you tested your own house for either of these hazards:

Asbestos [ ] no [ ] yes

Radon [ ] no [ ] yes

e. Have you heard of any government standard or "action level" for asbestos in homes?

[ ] no
[ ] yes -----> What do you think is the government action level?
Level is: ________ [ ] don't know

f. Have you heard of any government standard or "action level" for radon in homes?

[ ] no
[ ] yes -----> What do you think is the government action level?
Level is: ________ [ ] don't know

THANK YOU FOR YOUR TIME AND HELP! If you want a copy of some of the other brochures we're testing, please fill out the mailing label and include it in the envelope when you mail back the questionnaire.

___ ___ ___ ___ **Cond.** ___

EXPERIMENT III

Cover Page for Radon Questionnaire

THE STATE UNIVERSITY OF NEW JERSEY

RUTGERS

Cook College · Department of Human Ecology

P O Box 231 · New Brunswick · New Jersey 08903 · 201 932-9153

Dear New Jersey Resident:

Thank you for talking with us on the phone and for agreeing to take part in our project. At Rutgers we are developing different information brochures for people who test their homes for radon. The feedback questionnaire you return will show us whether the brochure we sent you is helpful.

There are no right or wrong answers. We need to get <u>your</u> reactions and <u>your</u> opinions to evaluate the brochure. All your answers are kept confidential. The code number on the feedback questionnaire is only used to show us which questionnaires have been returned, so we don't call and remind people who have already mailed back their answers.

DIRECTIONS

Pretend that you have just had your house tested for radon. The testing company tells you that you have a reading of _________ **picocuries per liter on your first floor** and you are trying to decide whether you should do anything about it. Read the "Test Brochure" to help you interpret your imaginary test result and then fill out the questionnaire. FEEL FREE TO REFER TO THE BROCHURE WHEN ANSWERING THE FEEDBACK QUESTIONS. When you have finished, mail the questionnaire back to us in the envelope that we have provided. The Test Brochure is yours to keep.

THANK YOU VERY MUCH FOR YOUR HELP.

Sincerely,

Neil Weinstein Paul M Miller

Neil D. Weinstein, Professor
Peter M. Sandman, Professor
Paul M. Miller, Project Director

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Cook College · Department of Human Ecology
P.O. Box 231 · New Brunswick · New Jersey 08903 · 201/932-9153

Dear New Jersey Resident:

Thank you for talking with us on the phone and for agreeing to take part in our project. At Rutgers we are developing different information brochures for people who test their homes for asbestos. The feedback questionnaire you return will show us whether the brochure we sent you is helpful.

There are no right or wrong answers. We need to get <u>your</u> reactions and <u>your</u> opinions to evaluate the brochure. All your answers are kept confidential. The code number on the feedback questionnaire is only used to show us which questionnaires have been returned, so we don't call and remind people who have already mailed back their answers.

DIRECTIONS

Pretend that you have just had your house tested for asbestos. The testing company tells you that you have a reading of _________ **fibers per liter on your first floor** and you are trying to decide whether you should do anything about it. Read the "Test Brochure" to help you interpret your imaginary test result and then fill out the questionnaire. FEEL FREE TO REFER TO THE BROCHURE WHEN ANSWERING THE FEEDBACK QUESTIONS. When you have finished, mail the questionnaire back to us in the envelope that we have provided. The Test Brochure is yours to keep.

THANK YOU VERY MUCH FOR YOUR HELP.

Sincerely,

Neil Weinstein   Paul M. Miller

Neil D. Weinstein, Professor
Peter M. Sandman, Professor
Paul M. Miller, Project Director

6. If you continued to live in the home with your test result and didn't do anything about the asbestos, what do you think are the chances that you would eventually have some illness due to asbestos? (Even though you may feel uncertain, please circle an answer to tell us what impression you got from the brochure.)

no chance	very unlikely	unlikely	moderate chance	likely	very likely	certain to happen

How do you think you would feel if your own home actually had the asbestos level found by the imaginary test? (Please circle one answer in each row.)

7.	not at all concerned	slightly concerned	concerned	very concerned	extremely concerned
8.	not at all frightened	slightly frightened	frightened	very frightened	extremely frightened

9. What is your impression of how difficult it is to reduce the asbestos level if houses have a problem?
   [ ] very difficult
   [ ] fairly difficult
   [ ] fairly easy
   [ ] very easy

10. Let's say that reducing your asbestos level close to zero would cost a thousand dollars ($1000). Given what you have learned about the size of your present risk, do you think you would decide to carry out asbestos reduction measures?
   [ ] definitely would take measures to reduce the asbestos level
   [ ] probably would take measures
   [ ] cannot decide what to do
   [ ] probably would NOT take measure
   [ ] definitely would NOT take measures

11. If you continued to live in the home with your test result and didn't do anything about the asbestos, what do you think are the odds that you would eventually have some illness due to asbestos? (Please put a check in the box that comes closest to your opinion.)

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
no chance		1 chance in 1,000 (0.1%)		1 chance in 100 (1%)		1 chance in 10 (10%)		certain (100%)	no idea

12. At what asbestos level (in your main living area) do you think you would feel satisfied, so that you would not spend more money trying to get the level even lower?

[ ] NO asbestos
[ ] 0.5 fibers/l
[ ] 1 fiber/l
[ ] 2 fibers/l
[ ] 3 fibers/l
[ ] 4 fibers/l
[ ] 5 fibers/l
[ ] 6 fibers/l
[ ] 7 fibers/l
[ ] 8 fibers/l
[ ] 10 fibers/l
[ ] 20 fibers/l

For classification purposes, please tell us:

a. Your sex: [ ] male [ ] female

b. Your age: __________

c. How much school have you completed?

[ ] some elementary school
[ ] finished elementary school
[ ] some high school
[ ] finished high school
[ ] some college
[ ] finished 2-year college
[ ] finished 4-year college
[ ] some graduate study
[ ] graduate degree

d. Prior to receiving our brochure, how much had you read about asbestos:

[ ] very little
[ ] small amount
[ ] moderate amount (at least one information booklet or a magazine article)
[ ] a lot

e. Have you tested your own house, condominium or apartment for asbestos:

[ ] no
[ ] yes

f. Have you heard of any government standard or "action level" for asbestos in homes:

[ ] no
[ ] yes ——> What do you think is the government action level:
Level is: ________ [ ] don't know

THANK YOU FOR YOUR TIME AND HELP!
If you want a copy of some of the other brochures we're testing, please fill out the mailing label and include it in the envelope when you mail back the questionnaire.

APPENDIX B

EXPERIMENT II BROCHURES, FORMATS, AND QUESTIONNAIRES

Experiment II had four conditions for asbestos only – Base, Displaced, High Test Magnitude, and High Risk. The Appendix begins with the complete four-page brochure for the High Risk condition, with the format on the fourth page, followed by the Base, Displaced, and High Test Magnitude format pages. (The first three pages were identical for all conditions.) One question on the response questionnaire varied depending on the condition. The Appendix therefore includes one complete four-page cover letter and questionnaire (used for the Base and Displaced conditions), followed by the two variations of one page used for the High Risk and High Test Magnitude conditions.

EXPERIMENT II
COMPLETE BROCHURE
HIGH RISK CONDITION
Test Brochure*

2/90

BASIC ASBESTOS INFORMATION

WHAT IS ASBESTOS?

Asbestos is a mineral fiber found in rocks. There are several kinds of asbestos fibers, all of which are fire resistant and not easily destroyed by natural processes. Because of its desirable qualities, asbestos has been used in a wide variety of products including appliances, ceilings, wall and pipe coverings, floor tiles, and some roofing materials.

IS ASBESTOS DANGEROUS?

Although asbestos has many benefits for humans, it is also a very dangerous mineral. Breathing airborne asbestos fibers has been shown to cause: (1) Asbestosis - a serious lung disease which can lead to disability and death; (2) Lung cancer - a disease that is incurable and almost always fatal; and (3) Mesothelioma - cancer of the lining of the lung or abdominal cavities. The greater the exposure to asbestos, the more likely it is that one of these serious diseases will develop. Workers who handle or come into contact with asbestos on a daily basis are open to the greatest health risks.

There is no level of exposure to asbestos fibers that is completely safe. The greater the concentration of asbestos, the greater the risk.

HOW DOES ASBESTOS AFFECT US?

The danger arises when asbestos fibers are released from the product or material. These fibers are so small that they cannot be seen. They can float in the air for a long time and can pass through the filters of normal vacuum cleaners and get back into the air. Once inhaled, asbestos fibers can become lodged in tissue for a long time. After many years cancer or asbestosis can develop.

Cigarette smoking and asbestos together are especially hazardous. Exposure to asbestos plus smoking gives an even greater risk of lung cancer than adding the risk from smoking alone to the risk from exposure to asbestos alone.

Asbestos found in "friable" materials is most dangerous. Friable materials are materials that can be crumbled, pulverized,

* Because this is an experimental brochure, please check with other authorities before taking any actions in your home.

or reduced to powder by hand pressure. Asbestos insulation sprayed on a ceiling is an example of a friable material. In contrast, vinyl asbestos floor tile is not usually friable. The asbestos fibers are firmly bound or sealed into the tile and can be released into the air only if the tile is cut, ground, or sanded.

WHERE IS ASBESTOS LIKELY TO BE FOUND IN THE HOME?

There are several areas in the home where asbestos problems are most likely to arise. These include:

* Wall construction materials and pipe insulation, especially those dating between 1920 and 1972. (This includes materials found in and behind plaster or wallboard and in paper tape.)
* Friable ceilings in buildings built or remodeled between 1945 and 1978.
* Material found on stoves and furnaces such as insulation and millboard and door gaskets.

Other asbestos-containing products that you may find in the home include:

* Patching compounds and textured paints. (Since the use of asbestos in these products was banned in 1975, you are most likely to find it when sanding or scraping old or damaged material in older houses.)
* Vinyl floor tiles and flooring.
* Roofing, shingles, and siding.
* Appliances with asbestos-containing parts or components, such as toasters, broilers, slow cookers, dishwashers, refrigerators, ovens, ranges, clothes dryers, electric blankets, and popcorn poppers. (Unless broken or misused, most appliances with asbestos are safe. There has been a general decline in the use of asbestos in these appliances during recent years. If asbestos is still used, it is in parts which will probably not release fibers during use.)

Having significant amounts of asbestos in the home is not rare. Many old homes in New Jersey could create health problems for residents because of materials that may release asbestos fibers into the air.

HOW CAN I TELL IF I HAVE ASBESTOS IN MY HOME?

The manufacturer of a product may be able to tell you, based on the model number and age of the product, whether or not it contains asbestos. People who have frequently worked with asbestos (such as plumbers, or building or heating contractors) can often tell you whether or not material contains asbestos by looking at it.

Problems may occur in the home where asbestos-containing materials are worn, damaged, or exposed to the air. If you have ceiling or wall material that is crumbling, or you are preparing a major renovation which will expose material contained behind a wall, you should havethe material analyzed to determine if it contains asbestos. Laboratory analyses range from about $20 to $40 per sample. Several samples may be required to gain an accurate determination of asbestos content.

If you suspect that you have a problem, you may also want to have an air sample taken to measure the amount of asbestos fibers circulating inside your home. To collect the sample, a laboratory will send a technician to your home. A pump is used to draw air from the room into a filter that will trap the asbestos. An electron microscope is used to count the number of fibers trapped in the filter. It takes about six hours to collect the sample and costs between $100 and $400, depending on the laboratory and technique used. The results of the test can be reported in units of "fibers per deciliter of air" (one deciliter is one-tenth of a liter), abbreviated as f/dl. This unit tells how much asbestos there is in one deciliter of air.

WHAT SHOULD I DO IF I HAVE AN ASBESTOS PROBLEM?

If you discover that you have an asbestos problem, the best thing to do is to contact a contractor who has experience in the proper procedures for repairing and removing asbestos. There are special guidelines for handling asbestos-containing materials. You should avoid drilling, scraping, sanding, brushing, sweeping or vacuuming asbestos materials. This will disturb tiny asbestos fibers, make them airborne, and increase the risk of breathing them. It is highly recommended that you hire an experienced contractor or get professional advice if you are thinking of doing the work yourself. A contractor will seal off the contaminated area from the rest of the house and workers will use protective clothing and a special respirator while they are handling the asbestos. Using improper techniques can make an existing problem much worse by contaminating the entire house. For more information about identifying, testing, handling, and fixing asbestos problems call the N. J. Department of Health toll-free at 1-800 624-2376.

INTERPRETING YOUR TEST RESULT:

Use the three columns on the next page to interpret the imaginary test result we gave you. First, look down the column on the left, headed "Asbestos Level," and find the number nearest to your test result.

Next, move to the middle column, the one with the heading "Extra Cancer Deaths." The number in this column tells you how many people are expected to get cancer out of every 1000 people who live in a home with the same asbestos level as yours.

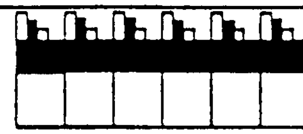
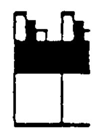
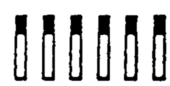
Finally, move over to the right hand column, the one titled "Comparison to Smoking Risk." It tells you how many cigarettes a day a person would have to smoke to have the same cancer risk as living with your asbestos level.

INTERPRETING YOUR TEST RESULT:

Asbestos level (f/dl)	Extra Cancer Deaths (Out of 1000 People)	Comparison to Smoking Risk
1500	Over 700 in 1000	
750	Over 700 in 1000	
350	700 in 1000	
150	300 in 1000	 6 packs/ day
75	150 in 1000	
35	70 in 1000	
15	30 in 1000	 1/2 pack/ day
7.5	15 in 1000	
3.5	7 in 1000	 3 cigarettes/ day

EXPERIMENT II
FORMAT PAGE
BASE CONDITION

INTERPRETING YOUR TEST RESULT:

Asbestos level (f/l)	Extra Cancer Deaths (Out of 1000 People)	Comparison to Smoking Risk
1500	300 in 1000	 6 packs/ day
750	150 in 1000	
350	70 in 1000	 1 1/2 packs/ day
150	30 in 1000	
75	15 in 1000	 6 cigarettes/ day
35	7 in 1000	
15	3 in 1000	 1 cigarette/ day
7.5	1.5 in 1000	
3.5	.7 in 1000	 1/4 cigarette/ day